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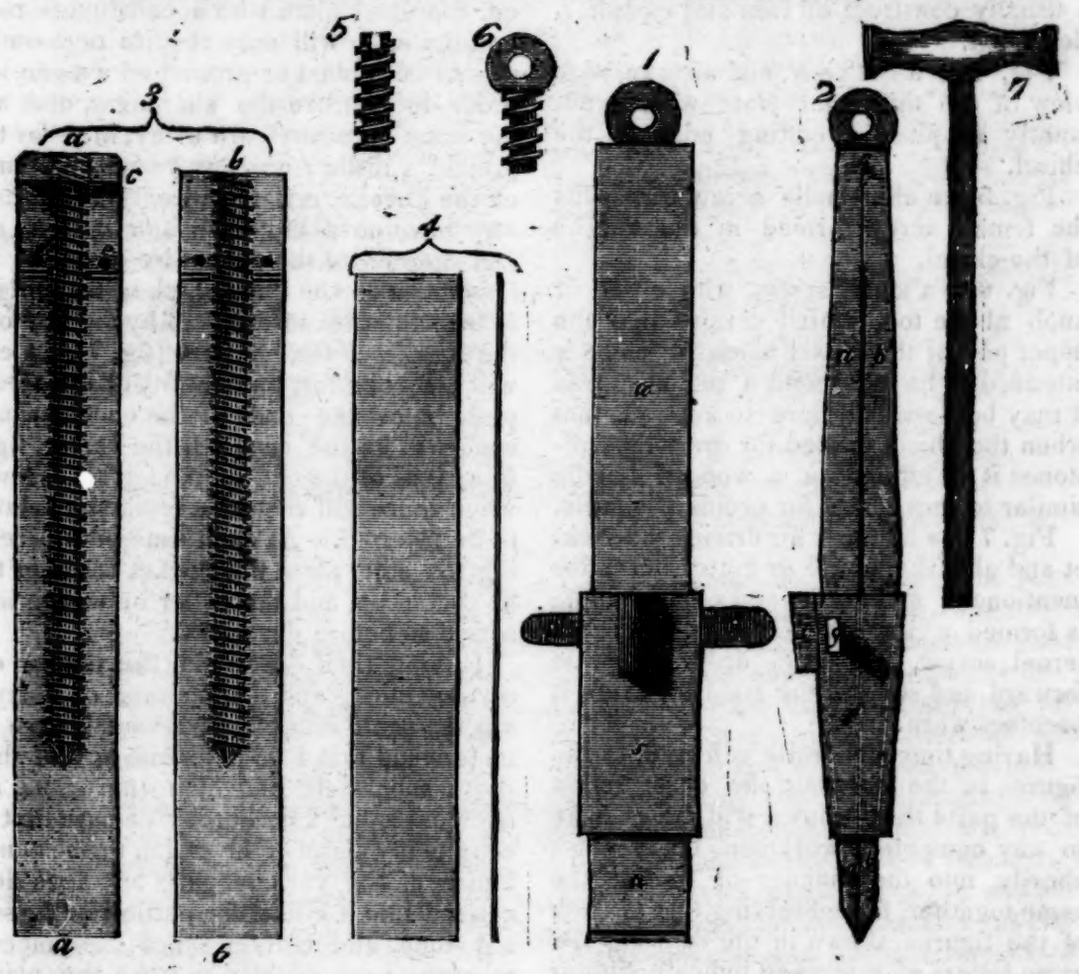
SMITH'S IMPROVED CHISEL FOR CUTTING OR DRESSING STONE, ETC.



[From the Repertory of Patent Inventions, &c.]

Specification of the Patent granted to JOHN SMITH, *for a certain Improvement on Chisels or Instruments for cutting or dressing Stone, and certain other Substances.* Sealed December 23, 1834.

In ordinary millstone chisels, and also in chisels for cutting, dressing, or working other stone, and also for dressing cast iron, it is well known that the cutting edges quickly become worn, and consequently constantly require sharpening, which operation is performed by heating the same and forging such cutting edges to the degree of sharpness required; the operation of tempering is then to be performed; all which requires much time and judgment, and in places distant from a forge becomes a matter of considerable consequence. Now, the object of my invention is to use a thin plate of steel, properly tempered, which being supported on either side by cheeks, such steel plate, (as it becomes worn,) being capable of movement in order that a sufficient quantity for the cutting edge shall project beyond the ends of the cheeks, yet such thin steel plate, when in use, is

rigidly held between the two cheeks, and prevented receding from its work by a screw, whereby the whole, when combined, will produce a strong and highly useful chisel, as will be hereafter more clearly described.

Fig. 1 represents the side view of a chisel constructed according to my invention.

Fig. 2 an edge view thereof.

Fig. 3 represents the two cheeks, which I usually construct of iron and case-harden them.

Fig. 4 is a flat view, and also an edge view of the thin steel plate which constantly supplies a cutting edge to the chisel.

Fig. 5 is a short male screw which fits the female screw formed in the cheeks of the chisel.

Fig. 6 is a small screw, with a ball or knob at the top, which screws into the upper part of the chisel when the same is intended to be used with a mallet. And it may be desirable here to remark, that when the chisel is used for dressing millstones it is affixed in a wooden handle similar to those used for ordinary chisels.

Fig. 7 is a hammer for driving the socket and also the wedge or cotter hereafter mentioned; and on the end of the handle is formed a key for screwing up the internal screw, fig. 5, in order to press forward and support the steel blade as it becomes worn.

Having thus generally referred to the figures in the drawing, the construction of the parts there shown will be evident to any competent workmen, I will enter shortly into the manner of putting the same together, first observing that in each of the figures shown in the drawing the same letters of reference indicate similar parts. *a* and *b* are the two cheeks which constitute the main frame of the chisel; these cheeks go together by means of the mortice, *c*, and the studs, *e*, *e*, which latter into recesses formed in the cheek, *b*, as will be evident on inspecting the various figures. The thin steel plate is next inserted between the two cheeks, *a*, and *b*, the socket, *f*, is then to be placed on the end of the cheeks of the chisel, which being wedge form, the driving up of the socket will cause the same to bind more closely on the steel plate between them, and hold the same rigidly, and thus prevent lateral spring. It should be remarked, that on the cheek, *a*, is formed a groove, and in the socket, *f*, are two openings through which the wedge or cotter, *g*, is inserted and driven, by which the whole of the parts are securely held together. The screw, fig. 5, is to be screwed up within the female screw, in order to press against the other end of the steel plate, to assist in preventing its receding from its work. In using a chisel so constructed, the steel plate which constitutes the cutting edge will only require occasionally to be rubbed or ground on a stone in order to improve the sharpness, and as the same becomes worn away, in order to project a further quantity beyond the end of the cheeks, *a*, *b*, it will only be necessary to remove the wedge or cotter, *g*, and slide down the socket by giving it a few blows on the knob, *i*, the screw, fig. 5, may then be screwed up by the key on the handle of the hammer (fig. 7), which will project a further quantity of the steel plate below the ends of the cheeks, and such will be the case till the screw, fig. 5, arrives at the end of the female screw, when there will require a fresh steel plate to be inserted. At each time of projecting the steel plate the socket is again to be driven up, and the cotter or wedge inserted as before described.

Having thus described the nature of my invention, and the manner of carrying the same into effect, I would have it understood that I do not claim any of the parts separately of which the same is composed, but I do hereby declare that I confine my claim of invention to the combining of the various parts as above described into a chisel for cutting or dressing stone, and certain other substances, whereby I am enabled to use a thin plate of steel as the cutting edge, which may from time to time, as it becomes worn, be projected forward and offer fresh quantities for use, and yet, when in use, be rigidly held between the two cheeks, and prevented receding by the male screw, as above described.

Enrolled Feb. 23, 1835.

[From the London Mechanics' Magazine.]

HUNTER'S STONE-PLANING MACHINE.

In March last, a patent was granted to Mr. James Hunter, of Leys Mill, Arbroath, "for certain improvements in the

art of cutting, or what is commonly called facing and dressing certain kinds of stone." The specification of Mr. Hunter's method has not yet been enrolled; but from a Report, with a copy of which we have been favored, made to the proprietor of the Leys Mill Quarries, (W. F. L. Carnegie, Esq.,) by Messrs. Carmichael and Kerr, engineers, of Dundee, who were invited to see the method in actual operation at these quarries, and to verify the results, it appears to be immensely superior to any other hitherto devised. Mr. Hunter has seemingly realized that great desideratum, a power-machine for the cutting and dressing of stone, capable of withstanding the extraordinary friction to which it must necessarily be subjected. The despatch with which immense blocks of stone are cut up and dressed, by Mr. Hunter's apparatus, is prodigious; yet the cost of tools is next to nothing—"only a half-pennyworth of steel for every hundred feet of planed surface!"

Report of Mr. Charles Carmichael and Mr. John Kerr, Engineers, Dundee, on the power of Mr. James Hunter's Stone-planing Machine.

Sir,—Agreeably to your desire, we have visited Leys Mill Quarries, and attended minutely to the performance of the stone-planing machines. These machines do their work most effectually, as the following experiments, which we witnessed, will testify.

Experiment First.

We went to one of the machines that had six stones laid on the bench, one of which was planed, and the second begun to be operated upon; while this was doing, we took the dimensions of the other four stones, viz.:

Number of Stones.	Length of Stones.		Breadth of Stones.		Thickness.	Finished Thickness.	Quantity taken off.
	ft	*in.*	*ft.*	*in.*	*inches.*	*inches.*	*inches.*
1	5	3	2	6	$3\frac{1}{2}$	$2\frac{1}{2}$	1
2	5	0	2	8	3	$2\frac{3}{8}$	$\frac{5}{8}$
3	5	6	2	6	6	$4\frac{1}{4}$	$1\frac{3}{4}$
4	4	0	2	3	4	$2\frac{1}{2}$	$1\frac{1}{2}$

The average thicknesses of the above stones are given, but many parts of them were much more than the thickness stated. One of the broad finishing tools was blunted ere the experiment began, and was changed when No. 2 was in the operation of being planed. No. 3 was a very hard stone, and was what is technically called yolk, in planing which one of the roughing tools broke at the point; still it wrought out the stone, and was then replaced. A splinter came off the face of the last stone, when about half finished, which was another cause of delay, as they had to go over it again; but, notwithstanding the delay occasioned by the breaking of one tool, by another being changed, and by having to go over the one half of the last stone twice, yet the time altogether was forty-five minutes, being at the rate of sixty-five superficial feet per hour.

Experiment Second (same machine.)

Five stones were now put on the planing machine, of the following dimensions, viz.:

Number of Stones.	Length of Stones.		Breadth of Stones.		Thickness.	Finished Thickness.	Quantity taken off.
	ft.	*in.*	*ft.*	*in.*	*inches.*	*inches.*	*inches.*
1	4	3	2	2	$4\frac{1}{4}$	$2\frac{1}{4}$	2
2	3	9	1	10	$4\frac{3}{4}$	$3\frac{1}{2}$	$1\frac{1}{2}$
3	3	4	2	8	6	4	2
4	3	6	2	0	$6\frac{1}{2}$	$4\frac{3}{4}$	$1\frac{3}{4}$
5	3	8	3	6	$5\frac{1}{2}$	$4\frac{1}{2}$	1

These stones were planed in forty-two minutes.

The above stones were taken from the quarries without selection, and the men that were working the machine were not informed of the object of our visit. Experiment first began at half-past twelve o'clock, noon, and experiment second was concluded at nine minutes past two; thus leaving twelve minutes for cleaning and reloading the bench of the machine. Had all the stones been $5\frac{1}{2}$ feet long, they would have been planed in exactly the same time, for the machine travels the distance for that length; so that nearly sixty-seven feet of surface would have been planed in forty-two minutes.

The stones, as they come from the machine, are remarkably smooth and straight on the face; and were it not for the shade left by the tools, we would be apt to think them polished, as they feel as smooth as a polished stone.

We were told by the foreman, that during the last week there was planed* 4,400 superficial feet, more than half of which was planed on both sides, (indeed more than half of all the stone that leave

* See subjoined Note by Mr. Carnegie, on this point.

the quarry are planed on both sides,) by four machines. We saw the pay-list for the week: the amount was £6 1 6

Add blacksmith for dressing and grinding tools, 12 0

£6 13 6

We were further informed by the manager, that during the last summer there were upwards of 100,000 feet of pavement planed by four machines; and there was one thing that struck us most forcibly, which is the small degree of wear on the tools. Three shillings a week, or sixpence per day, is the cost of the labor for dressing and grinding the tools of one machine; and the whole consumption of steel during the last year was under a hundred weight, so that, if we measure both sides of those stones that were actually planed on the two sides, it will be seen a pound of steel will plane 1,500 feet, or about a half-pennyworth of steel for every 100 feet of planed surfaces.

There are now five machines working in the quarry, wrought by a steam engine of six-horse power, the steam cylinder of which is sixteen inches diameter, stroke two feet. Besides the machines, the engine has to work two inclined planes, one of which is for dragging up the pavement from the quarry to the machines; the distance on the incline 48 feet, ascent 1 foot in 5; average quantity about thirty tons per day of ten hours.

The second incline is for dragging up the rubbish from the quarry to the place where it is deposited; distance 87 feet, ascent 1 foot in 4; quantity from 50 to 60 tons per day of ten hours.

The above shows what the engine is actually doing; and we have no hesitation in saying that the engine would work eight machines besides the inclines without being overloaded; and our opinion is that a machine, on the average, is not much more than one-half-horse power.

We are, Sir, your most ob't serv'ts,

C. Carmichael,

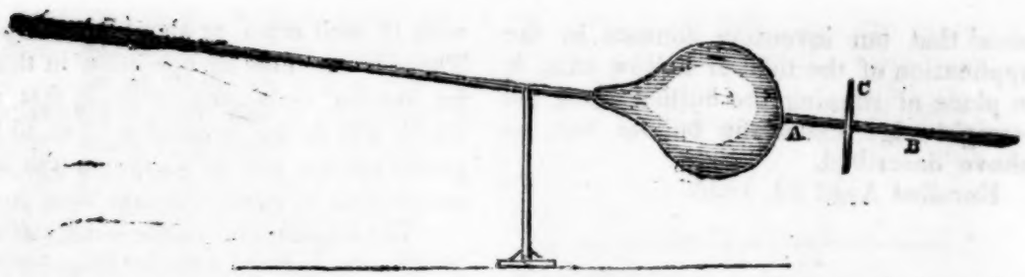
John Kerr.

To W. F. L. Carnegie, Esq., Kimblethmont, Arbroath.

Note by Mr. Carnegie.

To explain the difference which is apparent between the quantities of planed stone, which, according to the statement of the engineers, *might* be produced in a given time by the machines, and the quantity stated to them as in one week actually sent to market, it is necessary to remark,—1st, That it is found in practice to be cheaper to dress the stones by the machine in the rough state and shapeless form in which they are taken from the quarry, and to square them by hand afterwards, than to follow the opposite course, as is done where the whole work has to be performed by hand; thus a great quantity of work measured by the engineers, but not available in the market, is nearly lost. 2d, A considerable quantity is required to be dressed over twice on one side, or on both sides, according to circumstances; thus the stones, No. 3, in Exp. 1, and Nos. 2, 3, 4, 5, in Exp. 2, being too thick, were redressed on the under side to suit the market. 3d, The quarry does not always afford stones of a size to fill the benches, when much power is lost, as the machine has to traverse the whole width. 4th, Other circumstances, (such as bad weather, &c. &c.,) which will readily present themselves to the minds of those conversant in these matters, always occur to prevent general results from attaining the extreme limit, which may be calculated as possible from the data of a short experiment. Mr. L. C. having been present, can confidently testify as to the correctness and impartiality with which these experiments were conducted, and to the truth of the information furnished to the engineers, by those in his employment.

Steam Engines in Glasgow.—To such an extent is the business of steam engine making now carried on here, that there are thirteen firms engaged in it. Some of the works are more like national than private undertakings. Three houses alone employ upwards of a thousand persons. Dr. Cleland has ascertained that in Glasgow and its suburbs there are thirty-one different kinds of manufactures where steam engines are used, and that in these, and in the collieries, quarries, and steamboats, there are 355 steam engines, equal to 7,366 horse power—average power of engines rather more than 20 horse each.—[Ency. Britt., 7th edition.]



[From the Repertory of Patent Inventions, &c.]

Specification of the Patent granted to JAS. *and* JOHN HARTLEY, *for a certain Improvement or certain Improvements in the Manufacture of Glass.* Sealed October 22, 1834.

Our invention relates to part of the process employed in the manufacture of that description of glass called crown glass, used for the purpose of glazing windows and other purposes. It is well known that this description of glass is produced from the metal by blowing the same into the form of globes, and afterwards, by means of the operation called "*flashing*," such globes are thrown open into flat circular plates called tables. Now, our invention relates to that part of the process of manufacture which consists in blowing the metal into globes. According to the ordinary process, the metal when taken from the pot by the pipe is rolled on a smooth iron surface, in order to bring the outer end of the metal to a conical form, the extreme end of which becomes the outer axis of the globe during the operation of blowing and working the glass into the required form. This outer axis is called the bullion. During the expanding of the metal into the globular form, the workman rolls the bullion along a straight edge, or bar, called the bullion bar, as is well understood. In doing this, the outer end of the glass globe, whilst expanding, and continually revolving, rubs against the bullion bar, by which action parts of the surface of glass is disturbed or made irregular, and as the globe extends in dimensions this rubbed surface enlarges: the consequence is that when the table of glass is complete, there are at all times more or less waved lines for some inches around the bullion or the centre of the table of glass, which lessens the value of so much of the table. This prejudicial appearance is produced to the glass as before stated by that part of the surface coming in contact with, and rubbing against, the bullion bar, when the metal is in a soft and pliant state. Now, the object of our invention is to dispense with the bullion bar, and to supply its place by the application of a tube or hollow bearing for the bullion or outer axis of the globe of glass during the expansion of the same: by this means that part of the surface which was heretofore rubbed against the bullion bar, is, when worked according to our invention, in no way prejudicially acted on, and the waved appearance before consequent on the manner of operating is avoided.

The drawing represents an ordinary pipe with a globe of glass, the bullion, *a*, being supported by the tube, *b*, in which it is caused to revolve by the workmen when working the metal into the globular form desired during its expansion. On the tube *b* is placed a shield, *c*, which is intended to prevent the heat coming from the heated glass, injuring the hands of the boy who holds the tube. The workman, in performing this part of the process of manufacturing glass, takes a proper quantity of metal on the end of the pipe, and proceeds to form the outer end of such metal into a cone; he proceeds with the process in like manner to that heretofore pursued till the globe of glass requires support at the outer end by its axis or bullion, *a*, that is to say, he proceeds in the ordinary manner up to the period at which (according to the old means of operating) the bullion would have been rested on, and revolved, and run along the bullion bar, but in place of so running it along the bullion bar, a boy holds the tube or hollow bearing, *b*, in such manner as to receive the bullion, *a*, and the workman causes the globe to revolve till the globe is sufficiently expanded. The same is then to undergo the operation of flashing as heretofore.

Having thus described the nature of our invention, and the manner of carrying the same into effect, we would have it under-

stood that our invention consists in the application of the tube or hollow axis, *b*, in place of running the bullion along the straight edge, called the bullion bar, as above described.

Enrolled April 22, 1835.

AVERY'S ROTARY ENGINE.—After a long and vexatious, and yet unavoidable delay, we are enabled to give a drawing of Avery's Rotary Engine, of which we have frequently spoken before. The annexed drawing is taken from a *two*-horse power engine, built for this office, to drive a printing machine, which prints both sides of the sheet before it leaves the press. This engine, as it will be seen, together with the boiler, force pump, and governor, and, in short, *every thing necessary* for communicating motion to them and to the machinery to be operated, occupies a very small space, it being only 4 feet 8, by 2 feet 10 inches. The boiler is 17 inches in diameter, and 78 inches high; the furnace for anthracite coal occupying about one fifth part of it.

The principal advantages of this engine, as we conceive, consists in its compactness, the ease with which it is managed by any person who can tend the *fire*, the trifling cost of fuel, as well as the small outlay for the engine. The most important advantage, however, for many purposes, and especially for driving *printing machines*, will be found in its perfectly uniform motion. It is indeed so perfect, and the velocity so great, being about *five thousand* revolutions of the arm, shaft, and of course pulley on which the band runs, per minute, that but for other than the ordinary machinery attached to the engine, a casual observer would scarcely know that a steam engine was in operation.

In No. 12, vol. iv., of the Railroad Journal, is published an account of the performance of an engine used by the proprietors, Messrs. E. Lynds & Son, in their shop at Syracuse, New-York, which has now been in use more than two years, and we cannot do better than to re-publish a part of that article.

The following extract refers to an engine with 18 inch arms, of 6 horse power, but the engraving given herewith represents one with 12 inch arms, or about 2 horse power. There is one now in operation in this city for sawing mahogany, with 2½ feet arms, which will do the work of a 12 or 15 horse power engine, and performs to the entire satisfaction of those who use it.

"The engine, that is, the shaft and arms, weigh, as I learn, only 15 lbs.; the arms, from centre of shaft to their ends, are 18 inches, and in their revolutions describe a circle of 9 feet 5 inches in circumference; the two apertures at the end of the arms are equal to the eighth part of a superficial inch, and under a pressure of 80 lbs. to the square inch, will balance a weight of 10 lbs. From some experiments made, it is estimated to carry a load of 8 lbs. through a space of 37,666 feet per minute. The boiler has 66 feet surface exposed to the fire, and consumes daily half a cord of soft dry wood.

There are in the establishment the following machines in operation, namely, 2 large engine lathes; 2 small do. do.; 2 hand lathes; 1 boring mill for boring cylinders; 2 drilling lathes; 1 grindstone; 1 mill for grinding coal; 2 bellows, 40 double strokes each per minute, which will force 580 cubic feet of air per minute, under a pressure of 1½ lbs. per square inch, and requires 4 to 5 horse power to perform its operation of melting 1500 lbs. of iron per hour."

The following references will give an idea of the engine; to examine it, however, will be more satisfactory.

A, the boiler, 17 inches in diameter, and 78 inches high, standing on a cast iron frame, with a grate inside.

B, the steam pipe, which conducts the steam to the end of the shaft C C, one end of which is enclosed in a superfluous cast iron tube. The steam is ordinarily conducted from the boiler to the end of the shaft in a simple steam pipe, which may be six inches, or 6 or 12 feet in length, to accommodate the engine to the machinery, without regard to the position of the boiler.

C C, the shaft passing through the case D, and the arms Q, Q, fig. 2, which are enclosed, and revolve in the case D. On this shaft, as will be seen in fig. 2, is the pulley E, from which the band passes to the machinery.

D, a circular cast iron case, in two parts, fitted and put together with bolts, and made steam tight. This case has in some instances been made of sheet iron; cast iron, however, is deemed best. The case, al-

Avery's Rotary Engine.

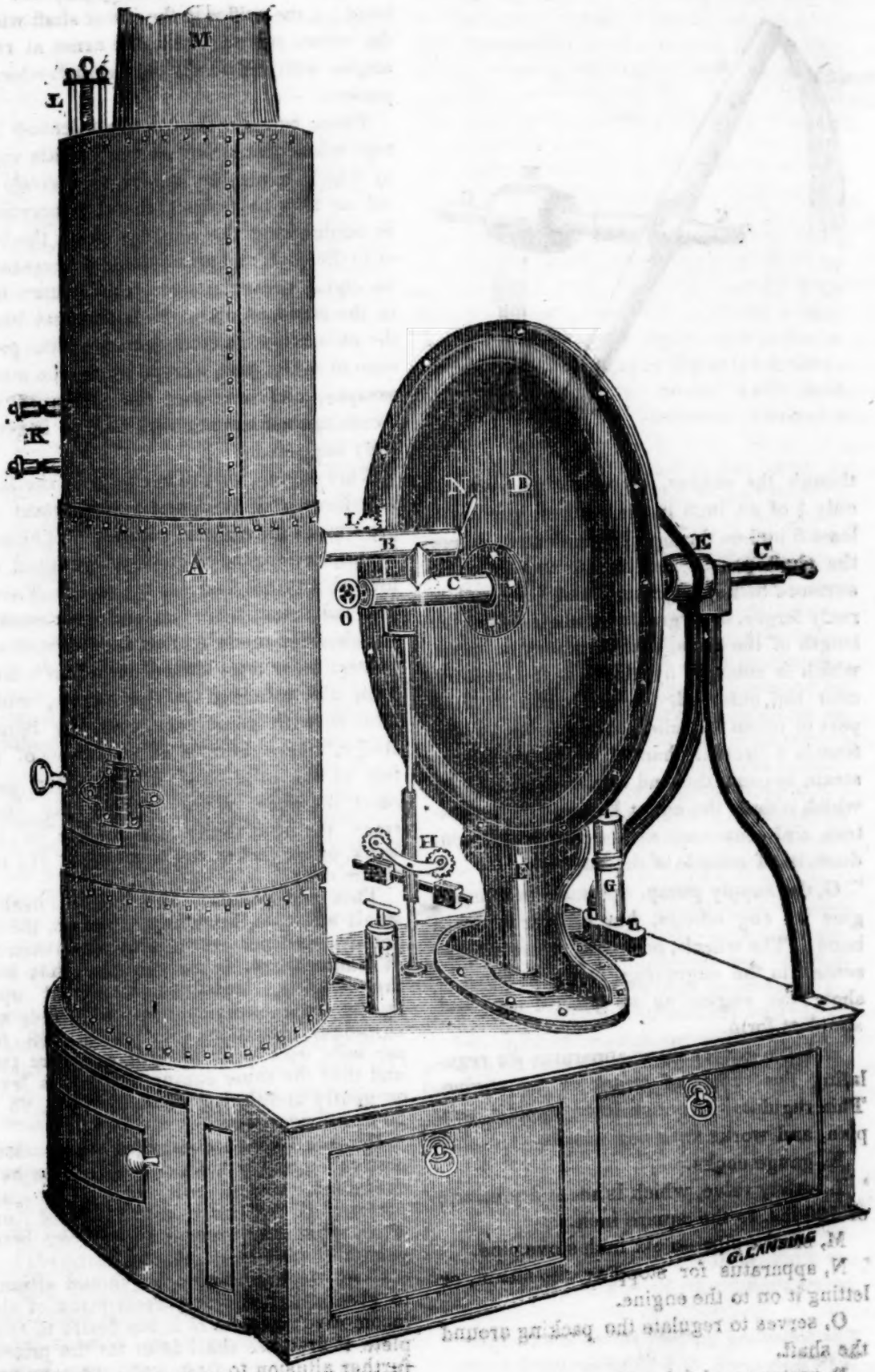
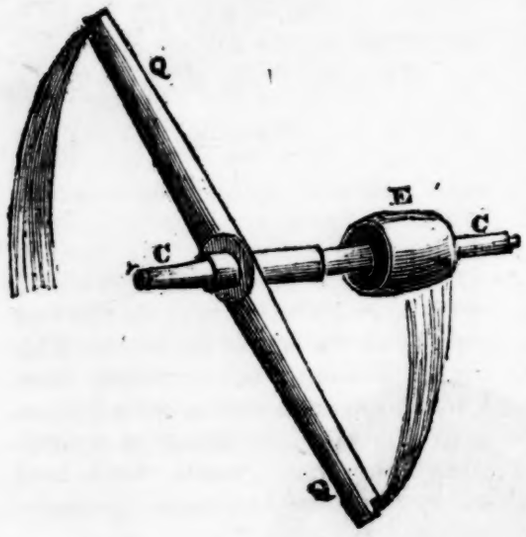


Fig. 2.



though the engine, or revolving arm, is only ⅜ of an inch in the thickest part, is at least 5 inches through in the centre, where the shaft passes, having the two concave surfaces turned together; and it is considerably larger, or of greater diameter, than the length of the arms, that there may be space, which is enlarged by giving to the casting, near the outer edge, a half circle in each part of about 3 inches in diameter, which founds a circular channel or groove for the steam beyond the end of the arm, and by which it finds the outlet F, through the bottom, and connected with a pipe which conducts it off outside of the building.

G, the supply pump, operated in this engine by cog wheels, but ordinarily by a band. The wheels, however, are not represented in the engraving, being desirous to show the engine as in general use, and simplest form.

H, I, the governor, or apparatus for regulating the supply of steam to the engine. This regulator is constructed upon a new plan, and works with cog wheels.

K, gauge cocks.

L, safety valve, which is set at a pressure of 100 lbs. to the square inch.

M, smoke pipe—a six inch stove pipe.

N, apparatus for stopping the steam, or letting it on to the engine.

O, serves to regulate the packing around the shaft.

P, water supply pipe.

Fig. 2.—C C, shaft; E, pulley for the band; *r*, the orifice in the end of shaft where the steam enters; Q Q, the arms at right angles with the shaft, and through which it passes.

There being a free communication (except when obstructed by the throttle valve, by which it may be *in part, or entirely* cut off, as may be desired, thereby increasing or diminishing the velocity,) from the boiler to the shaft and arms, there is necessarily an equal pressure upon the square inch of the arms, as upon the boiler, and hence the RE-ACTION, in consequence of the pressure in every part, except where the steam escapes, and not from the action of the steam against the atmosphere, as is generally supposed.

This engine, we are yet fully in the faith to believe, will be found an important improvement for *railroad purposes.* The only locomotive engine of the kind ever used, run for a short time, last spring, on the *Newark* railroad; and, after various experiments, which were made to test its qualities and power, a car was loaded with four tons of iron, and attached to the engine, which took it, with great ease, over the Bergen Ridge, where there is an elevation of 152 feet to the mile—and in one place, for a *short* distance, when leaving the direct track for that built temporarily on the bank, *of six feet in one hundred,* or 312 feet to the mile.

This performance, although in itself a small affair, is, knowing, as we do, the ingenuity and perseverance of the inventor, *William Avery,* to us evidence that another engine, built and improved upon by the little experience already had, will surmount elevations of 150 to 200 *feet per mile, with loads of eight to twelve tons,* and that the same engine will, on a level, or gently undulating road, perform 35 to 50 miles per hour.

Mr. Avery is now engaged upon a locomotive engine, a model of which we have examined, which will, we doubt not, perform all we have here predicted; and if so, what can prevent them from being generally adopted on all our Railroads?

If we were at liberty, we should attempt to give a drawing and description of this locomotive; but, as it is his desire to complete it first, we shall defer for the present further allusion to it, or until we have permission to give a definite account of it.

[From the London Mechanics' Magazine.]

ADAMS' CIRCULAR SPRING WHEELS.

"Break all the spokes, * * * * *
And bowl the round nave down."

It has long been a desideratum amongst mechanicians, to accomplish the task of constructing a wheel for carriages intended to convey persons and goods over rough roads, which, while it should possess sufficient strength fitly disposed in its several parts to resist breakage, unsteadiness, or any permanent alteration of form, from any of the ordinary shocks or violence to which it might be subjected, should yet possess the property of elasticity to such a degree, as to intercept and materially diminish the concussion caused by the periphery rolling over obstacles during its revolution; and thus either prevent the concussion from extending its effects to the axis round which the wheel might revolve, or to lessen it so much that the effects might be comparatively innocuous. It must, of course, be necessary that the elastic power should be placed between the periphery and the axis, without in any way diminishing the roundness or altering the circular form of the periphery—which circumstance would tend materially to increase the rolling friction of the wheel: wherefore the only mode in which elasticity can be made available, must be by enabling the axis to depart sufficiently from the exact centre of the periphery where concussion takes place—to which exact centre the elastic force, pressing equally in various opposite directions in the plane of the wheel, should have a constant tendency to restore it when the effect of the concussion might cease. The advantages attendant upon a wheel so constructed are several and obvious.

1st, In ordinary sized wheels, used for a cart without springs, the concussion from the road is driven in a direct line along the spokes of the axis; and this concussion, constantly kept up as the wheel revolves, serves materially to increase the weight of draught, by forcing out the oil or grease, and bringing the rubbing surfaces of the axis and axis-box in close contact, to the increase of friction. This disadvantage would be removed entirely, or very materially lessened, by the use of an elastic wheel.

2d, In carriages with rigid wheels, to which the axis is attached by means of a horizontal spring bearing on the axis, the concussion is diminished, by its uniform bearing upwards; still it is but slightly, inasmuch as the momentum of the concussion passes directly along the rigid spokes to the axis; and, moreover, the relief which the spring affords is only in a vertical direction; in which direction the greatest amount of the momentum of concussion does not pass, but in a direction more inclining towards the line of progress as the wheel revolves. This disadvantage would be materially lessened by an efficient elastic wheel, inasmuch as the elasticity being in a circle all round the axis, would avail both against vertical and horizontal obstacles or inequalities.

3d, It is well known that the force requisite to move a carriage at first starting is greater than that required to keep motion up. The reason of this is, that momentum is required in proportion to the rapidity of the motion. Wherefore, every obstacle or inequality which the wheel encounters as it revolves, has a tendency to check the momentum, and render the draught power necessary to move the carriage onwards nearer in amount to that which was originally required to move it from a state of rest; because the concussion in the line of progress is nearly in direct opposition to the momentum, and serves to neutralize it. An efficient elastic wheel would be found to receive the concussion on its periphery, but as it would not carry it, or would carry it with a diminished force, to the axis, the momentum of the superincumbent framework, to which the draught power is attached, would scarcely be acted on by it.

4th, The wheels of carriages are subject to considerable concussion in a lateral direction, lengthwise of the axis. A rigid wheel, under such concussion, transmits the concussion almost unbroken to the carriage, to the annoyance of the passengers, and with a tendency to derange the framework. But an efficient elastic wheel would possess a small portion of lateral elasticity, sufficient to diminish the violence of the concussion, and yield greater ease of motion.

5th, An elastic wheel, by its tendency to elude concussion rather than to resist it, will be less liable to be broken or

strained than one which is rigid, and consequently its total durability is likely to be much greater. Wooden wheels, by reason of their property of elasticity, are less liable to break than those of iron.

Wheels are to a carriage what legs are to a human being—the instruments of locomotion. A man who loses an elastic leg, of bone, muscle, and ligaments, may have a wooden one to replace it; but he will find that the act of walking with the wooden one is a much ruder and less perfect process than with the one of bone and muscle; concussion, and the labor of surmounting or avoiding obstacles, will render the man's progress much slower. And it seems clear, that the property of elasticity in a wheel gives it a similar advantage over a rigid one that the natural leg does over the artificial one, though to a less extent; inasmuch as the mechanical contrivance of art must be inferior to the more perfect processes of nature. Ships, which are of rigid construction, are found to make a slower progress through the water than such as are slightly flexible; and in row-boats, the quality of flexibility is indispensable to swiftness: the reason is, that the flexible boat, as it advances, adapts itself, by its sinuosity, to the slight movements and currents of the water, which it eludes instead of resisting. The movement of a fish through the water is an illustration of the same principle; and, by a parity of reasoning, a carriage with elastic wheels avoids, by its yielding properties, many obstacles over which rigid wheels would require to be impelled by a greater exertion of power.

The general conviction of the advantages to be obtained by using elastic wheels has led to many attempts at their construction, but hitherto without any efficient result. One mode which was attempted was by arranging a number of pointed double elliptic steel springs in radiating lines from a nave to a periphery. To guard against the lateral action or leverage, these springs were doubled in number, and arranged at a lateral angle with the length of the nave each way. Even supposing such a wheel to be efficient, the expense of its manufacture would have precluded any extensive use of it; but the action was too imperfect, to allow much use without destruction of its parts. The elasticity of the springs could only be brought into action in the direction of the length of the ellipses, either by extension or compression; consequently the action could only be in a line diametrically across the wheel in one direction at a time: thus but few of the springs would be in action at one time, and that in a most imperfect mode, viz., in the length of a very long and narrow ellipse. The principle of an efficient spring wheel should be, that the elasticity should be alike at all parts of the circumference, and that no one part should act without the whole—that every spring should sympathise equally with the rest, from whatever direction a concussion might come. A wheel like that just described could not comply with this condition, and therefore such a wheel could not be durable. Another mode of forming a spring wheel was by making steel blades or ribbands in a sinuous or undulating curve, and forming them in radiating lines from a nave to a periphery, doubling them in the same manner as described in the elliptic spring wheel, to resist the lateral action or leverage. Supposing this wheel to be true and well made, the action would be more perfect than the former one; but the making of such springs all to stand their work equally well, and the needful accuracy of fixing them, would involve an expense too great for any extensive use; and after all, the action would be of that kind very likely to break the springs with a violent concussion. A third plan which has been proposed, but, we believe, never put in practice, is a small wheel placed within the circumference of a solid rigid ring of much larger diameter, the space between being supplied with several small hoops of ribband steel with open ends, put in with compression, so as to leave them free to enlarge or diminish their diameter when in action. These hoops were to be kept in their places by flanged segmental cavities adapted to their size in both wheel and ring, being otherwise unconfined by any fastening. The disadvantages of this form of wheel are many. First, its extreme want of elastic firmness; next, its want of universal action, being calculated only to act by compression on the springs below, and not by extension of the springs above. A great

defect would be, that while the weight were pressing on the lower springs, the elastic action of the upper springs would be directed, not to alleviate, but to increase the weight. In action, this wheel would be impracticable; for stones and dirt would lodge in the centres with the springs, clog their action, and break them. But one useful thing they contain, viz., the germ of the only sort of spring which can be effectively applied to spring-wheels—the circle. The wheel itself is a circle continually revolving, and springs intended to have an equal action in that wheel, whatever side be uppermost, must be circles likewise. No other form can be of universal action, in the place of the wheel; no other form will yield extensibility and compressibility in every direction in rapid succession, each tending alike to restore the nave to the exact centre of the periphery, as the momentary action of concussion passes away.

Mr. William Adams, a partner in the firm of Hobson and Co., of Long-acre, has marked this essential principle, and has had the perseverance to work it out in detail, so as to lay it before the public in a practicable form. The leading features of his invention are four hoops of broad steel plate, properly tempered, the ends of the hoops being overlapped and rivetted together, so that each hoop may be solid, by which means it will resist and yield equally, both by extension and compression. These hoops are affixed firmly at equal distances in the interior of a rigid circular rim, which forms the periphery of the wheel. This circular rim is made rigid by its peculiar mode of construction. An inner iron, or steel tire, of less substance than the outer one, is surrounded by a circle of wooden felloes, accurately fitted to the inner tire, and also with their ends accurately fitted to each other like a barrel arch, the lines of the joints meeting in the centre of the circle. Around this circle of felloes, so fitted, the outer tire is shrunk on hot, as usual, and all three thicknesses are rivetted together. In calling this a rigid rim, we do not mean that it is rigid like an iron casting, (for if it were so, it would not stand its work, but be liable to break, as cast iron wheels do;) but that, while it possesses a slight portion of elasticity sufficient to prevent breakage, it is also sufficiently strong to prevent any permanent alteration of its form by any ordinary concussion to which it may be subjected. To this rim the four hoop springs are firmly bolted, but do not in any material manner contribute to strengthen it. The springs serve as elastic legs; the rim serves as a foot to guide the steps they make in revolving. Wheelwrights call the act of putting a tire on a wheel, "shoeing it."

The nave of this wheel is made of iron flange plates, fitted to the axis-box, and reinforced by wood blockings. The flange plates are made in the form of a Maltese cross, and to the arms of this cross the hoop springs are firmly fixed, each with four clip bolts and nuts, without making holes in the spring; and this mode is found to ensure sufficient lateral strength to resist the central leverage of the wheel. The springs are tapered in width towards the circumference, in order to give the greatest elasticity towards the point of concussion. The axis-box is so contrived that it will carry a very large magazine of oil in actual contact with the axis, and the wheel is therefore likely to travel considerably farther without requiring fresh oil than any other kind, more especially as the elastic action removes the extra friction arising from concussion. Most oil axes are fed with oil by a capillary or pumping action. This action is liable to be disturbed from many causes, and if disturbed, the wheel will become fast on the axis by heating. But an axis in actual contact with the oil cannot be liable to these accidents.

One of the first considerations which struck us was, that a wheel with so much metal in it must necessarily be very heavy; but this proves not to be the fact. The peculiar action and combination of the springs being such that all mutually assist and are dependent on each other, the thickness of the plates is necessarily so much reduced below the ordinary standard of spring plates, that great lightness is combined with great strength. Thus a pair of these spring wheels are found to be just so much heavier than ordinary wooden ones as the weight of the inner tire amounts to. But as the axes used in ordinary rigid wheels are made much heavier than is needful for the weight they carry, in order to resist extraordi-

Fig. 1.

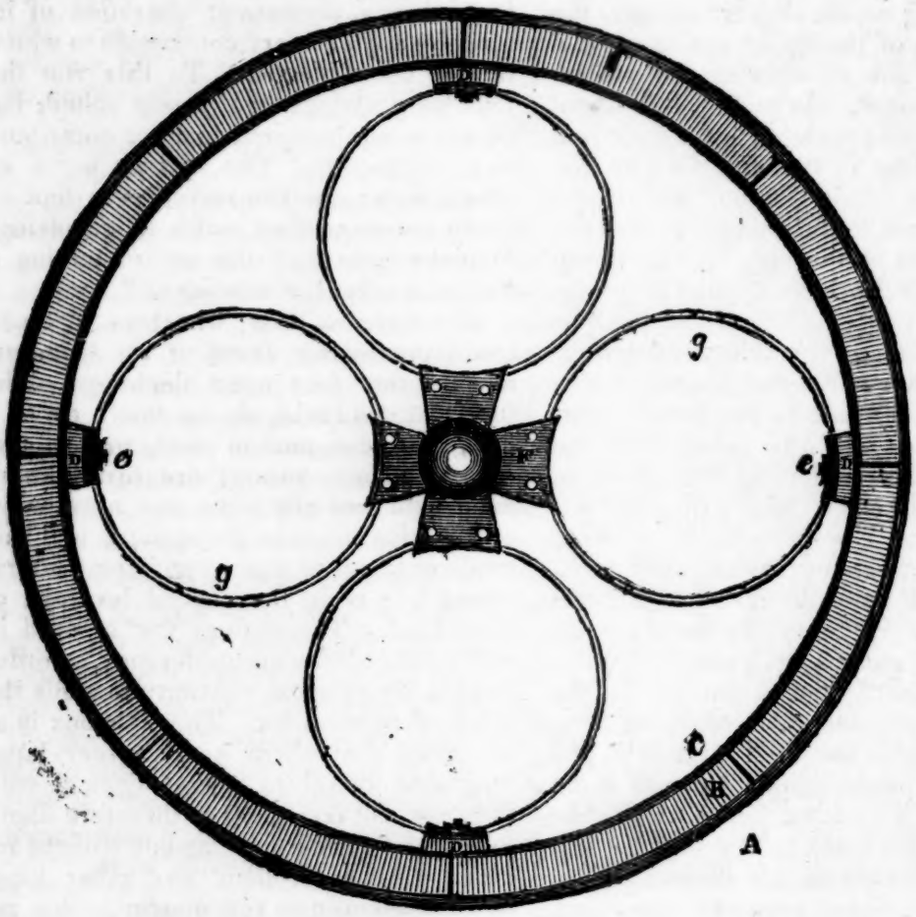


Fig. 2.

nary concussion, so the axis of the spring wheels, not being subject to the same amount of concussion, may be reduced in weight, in order partly to compensate for the tire; and the surplus weight being thus placed at the circumference of the wheel, instead of on the axis-bearing, the friction will be reduced: and, in addition to this, the freedom from concussion, consequent on the use of the elastic wheel, will enable a saving to be made in the weight and number of the carriage-body springs; and thus a farther amount of weight, and consequently of friction, will be removed from the axis-bearing. In the construction of a wheel-carriage, the weight, as well as the strength of the wheels, should always bear a certain proportion to the superincumbent weight, or the centre of gravity may be too high, a disadvantage nearly as great in a carriage as in a ship. A wheel may be too light as well as too heavy, and the former defect is the greatest. The former is a defect of principle, and is dangerous: the latter can only make a slight difference in the draught by additional weight, and not by additional friction on the axis-bearing; and, at a considerable speed, the weight of the heavy wheel acts with momentum like a fly-wheel.

Mr. Adams' elastic wheel is light and elegant in its appearance, and apparently well adapted for pleasure carriages on common roads; but there is a still more extensive purpose for it to serve—we allude to the railroads, whose increasing number and probable universality render economy in the mode of transport a most important object. It appears, from Mr. Wood's statements, that the difference of wear and tear between carriages with springs and carriages without, on railroads, is as one-quarter to one-half. The springs used in railroad carriages are very short, and have little play, and that only in a vertical line, which is not the line of concussion. At rapid speed, the necessity for elasticity increases in com-

pound progression. The speed used on railroads would tear a carriage to pieces on a common road. A small pebble, or a trifling inequality in the joint of a rail, at a high speed, gives a violent shock, and the momentum of each succeeding wheel, in a long train of carriages, like repeated rapid blows of a hammer, at each action increases the weakness of a loose rail, and ultimately breaks it, or renders it useless. As the elasticity of the spring-wheel acts in a direct line of concussion, both rails and carriages would be saved from it, and the total amount of friction considerably diminished. In the ordinary rigid wheels used on railroads there is occasionally a tendency, when not running in an exactly straight line, for the side of the flange which guides them to mount the rail, and thus overturn the carriage. It seems to us that the lateral elasticity of Mr. Adams' wheel would have a tendency to prevent this kind of accident; for the flange not revolving in a rigid plane, would slip downwards from the rail, as fast as a grinding contact might give it a tendency to mount, and the lateral elastic action would then tend to restore the track of the wheels to the proper position.

An elastic wheel possesses another advantage over a rigid one, in case of the defective construction incident to all wheels, viz., the absence of roundness, i. e. eccentricity of orbit. A rigid wheel of this form must necessarily move with much friction; but the elasticity of a spring-wheel would tend to correct this defect, by yielding where there was the necessity during its revolution.

For ordinary weights, the springs are made in single plates, by which means they may be effectually preserved from rust; but for heavy carriages and engines, the inventor proposes to multiply the number of plates in the same mode as other carriage springs.

Fig. 1 is a side elevation of the wheel. Fig. 2 is the cross section. A is the outer tire; B, the felloes; C, the inner tire; D, blocks to bend the springs on the rim; *e*, the clips to fix the blocks down the springs on the rim; F, the central Maltese cross and axis-box; *g*, the circular springs.

By the simplicity of construction, if a spring should break, it may be removed and re-placed, without taking a carriage off the road, in a few minutes. The railroad central nave is of still simpler construction than that for the common road.

FIVE HUNDRED DOLLARS PREMIUM.—The Directors of the City Hotel in Boston offer the handsome premium of five hundred dollars for the best plan for erecting an extensive Hotel, &c. on a site of ground containing 21,000 feet, directly opposite the passenger depot of the Worcester Railroad, in the South Cove. The plan, accompanied with drawings, to be presented to the Treasurer by the 15th September next.

New Hydrometer—Query.

To the Editor of the Mechanics' Magazine:

SIR,—In June, 1831, the notice now enclosed ran the rounds of all the London papers. It reads "a piece of metal," but what metal is not stated. May I request you to say in your next, whether zinc, platina, copper, or any other? If you are not aware which kind, please desire information in your valuable work.

Respectfully, your reader,

ASMODEUS.

July 18, 1835.

"A NEW HYDROMETER.—A new instrument to measure the degrees of moisture in the atmosphere, of which the following is a description, has been recently invented by M. Baptiste Lendi, of St. Gall. In a white flint bottle is suspended *a piece of metal* about the size of a hazel-nut, which not only looks extremely beautiful, and contributes to the ornament of a room, but likewise predicts every possible change of weather 12 or 14 hours before it occurs. As soon as the metal is suspended in the bottle with water, it begins to increase in bulk, and in 10 or 12 days forms an admirable pyramid, which resembles polished brass, and it undergoes several changes till it has attained its full dimensions. In rainy weather this pyramid is constantly covered with pearly drops of water; in case of thunder or hail, it will change to the finest red, and throw out rays; in case of wind or fog, it will appear dull and spotted; and pre-

viously to snow, it will look quite muddy. If placed in a moderate temperature, it will require no other trouble than to pour out a common tumbler full of water and put in the same quantity of fresh."

Any of our friends or correspondents who will solve this question, will much oblige.

Improved Draft of the Hull of a Steamboat.

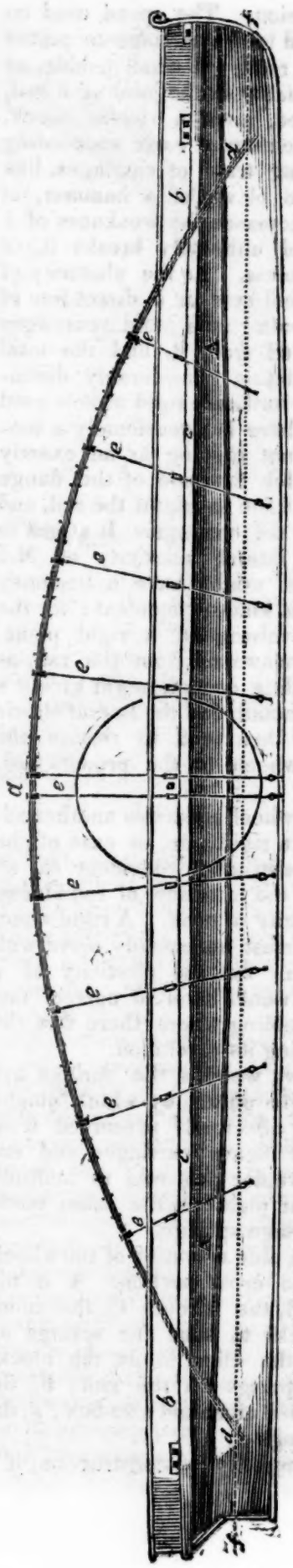
To the Editor of the Mechanics' Magazine:

SIR,—The favorable reception you gave an article of mine in your last number, has induced me to offer the annexed draft of the hull of a steamboat, with an *elevated* deck, and an *arched* or *semicircular bracing*, the objects of which are the more effectually to guard against the boat being thrown out of shape by the weight of the engine, boilers, &c., &c., and the depression of the bow and stern; or the necessity of building them with such heavy materials as to cause them to draw too much water for extreme speed, or the navigation of shallow waters; added to which, the raising of the deck in the centre (in this draft two feet) not only enables light and air to be more easily introduced to the cabins, but also brings the upper surface immediately under the water-wheel shafts, which both passengers and engineers must admit is a very desirable improvement.

I had prepared a full explanation of the draft according to my views, but upon deliberation concluded that, to those who are competent to judge of it, any explanation that I could give would be superfluous, preferring to defend its merits, if doubted, either in person or through the same medium this is given; at the same time, with all due deference, challenging a refutation of its advantages or origin, with the writer, although I am well aware that on the latter ground I shall be met with the fact, that two boats lately built are now running, each of which have improvements *somewhat* similar to the above, but it is no less a fact, that the design from which this draft is taken was made by me twenty-one months since, which can be duly substantiated by a

YOUNG ENGINEER.

Aug. 10, 1835.



A, A, the hull; *b*, *b*, the waistboards or bulwarks; *c*, *c*, the outer edge of the guard; *d*, *d*, *d*, the arched or semicircular bracing, consisting of six or more thicknesses of oak plank, 2 inches thick by 12 inches wide, fastened together by screw bolts and nuts, and firmly built in and bolted to the hull, at the extreme ends, supporting the boat by its connection with the kelsons, timbers, &c., with the wrought iron swivel screw bolts, *e*, *e*, *e*, *e*, converging to one common centre of a circle, of which the line, *d*, *d*, *d*, is an arc.

Note.—The dimensions and distances are not written, as the draft is drawn on a scale, viz., 25 feet to an inch.

[From the London Mechanics' Magazine.]

ANTIS' IMPROVED CHIMNEYS.

SIR,—If the following paper, abridged from *Hazard's Register of Pennsylvania*, will tend at all to a discontinuance of the revolting practice of employing climbing boys in chimneys, I shall be happy to see it in your valuable and instructive publication.

Yours faithfully, A. Z.

To construct a chimney which would carry smoke has been found in practice one of the most precarious objects of mechanism. So little has the theory of smoke and draft been understood, that if ever a chimney was constructed to draw well, it was evidently a matter of accident; for no mechanic seemed to have any rule for constructing chimneys which would ensure a good one. We have been extremely gratified within a few days, by the inspection of a flue, and a set of fireplaces, constructed upon a plan entirely new in principle, invented by Mr. Henry Antis. We had not the pleasure of seeing Mr. Antis' model; but we saw the practical effect of his discovery, by a chimney and fireplaces in operation, in the house of Mr. Joseph Wallace, in Front street, the success of which is complete, and triumphantly sustains Mr. Antis' theory on the subject. His theory is, that cold atmospheric air tends to the centre of gravity, till it meets with some obstruction, which gives it another direction; that heated or magnified air is exactly vertical in motion; that hence, the flue to carry it off should be perfectly vertical, and in no place of smaller dimensions than at the bottom or first inlet. He maintains that it matters not how many inlets there be to it, provided the area of a cross section of the flue be equal to those of all the inlets combined; it may be greater, but must never be smaller. He therefore starts with a single flue from the cellar, regulating the size to cover the area of all the contemplated inlets from bottom to top. He carries it up all the way of the same size, in exact perpendicular direction; nor need the wall be more than the width of one brick in thickness. Wherever he wants a fireplace, he attaches jambs of the usual shape, leaving the common perpendicular wall of the flue for a back, throwing an arch across at the proper place in the usual form, covering it tight to the back wall. Immediately opposite or below the covering of the arch, he leaves a horizontal aperture in the flue, the whole width of the fireplace, from jamb to jamb, in size according to calculation previously made, and according to the height of the arch, which, for jambs from twenty-four to thirty inches high, must not be less than three inches perpendicular in the opening.

There seems to be philosophy in this theory; and practice, so far as tried, proves that there is truth in it; and we have no doubt the plan will, on a little further trial, be universally adopted by builders.

Beneath each grate, fitted in a fireplace, is an opening left, which descends obliquely into the flue. In this opening, on a level with the hearth, is a fire grate fixed, through which the ashes descend from the grate above. And such is the effect, that while a strong current of air is produced by the heat from the fire in the grate, through the horizontal aperture above, a moderate draught is also maintained in the oblique one below, which carries off all the dust; so that from a coal fire not a particle of dust escapes into the room. He also affixes a valve to each inlet, hung in such an ingenious manner, that the mere pulling of a small brass knob closes it entirely; and thus, in case the chimney should take fire, all the currents of air may be stopped in a moment, and the fire dies at once. Not a particle of soot can ever enter your room or your fireplace; for that, as well as the ashes, all descend to the bottom of the flue in the cellar, where an opening, with a sheet iron door, is constructed, from which these articles can be taken, and through which a sweep may enter and perform his duties, without disturbing the business, or amusements, or quiet, of any part of the family. Where necessary, he also carries up side flues in the jambs, by which air can be introduced, to regulate the temperature of your room, or the force of your draughts.

The advantages of this improvement are,

1st. Fewer materials are used, which cheapens the work.

2d. Less room is engrossed by dead brickwork.

3d. No annoyances from soot or ashes in your rooms—not even when a sweep ascends to clean out your flue.

4th. Power to regulate the temperature of your rooms, without opening doors or windows.

5th. Perfect security against smoke in every room in your house.

NEW DESCRIPTION OF CABRIOLET.—A vehicle of this description, hung upon a new principle, has just been brought out at Paris, and is now all the rage there. Its advantages over the old one are greater lightness, easiness, and cheapness. The principal difference is in the mode of suspending the body. In the patent cab the square frame is dispensed with, and the substituted one may be best described by likening it to a hay fork, supposing the horse to work within the prongs, and the body to be built upon springs upon the handle, which is laid across the axletree. By the balancing of the body upon a single perch, the movements backward, forward, and laterally, are much easier, and the whole is rendered lighter. It of course requires good screwing at the point where all the springs radiate upon the beam of the scale, to maintain the body in its proper position, but as constructed it is said to answer well. The principle of resting bodies on a point in the middle, is not new in the construction of four-wheel carriages.—[London Morning Herald.]

[From the London Mechanics' Magazine.]

Bernhardt's Patent Warming and Ventilating Process.

Several indistinct notices have appeared in the newspaper press, both domestic and foreign, during the last twelve months, (and some, it must be confessed, of rather a high-colored description,) of a new mode of warming and ventilating, stated to have been discovered by Mr. Bernhardt, a Saxon architect of considerable eminence, and exemplified by him with extraordinary success in a number of public buildings on the continent. As Mr. Bernhardt has taken out a patent in this country for his invention, and the time for his specification has now nearly expired, we shall soon be enabled to lay the whole particulars of his plan before our readers; but, in the mean while, the following extracts from a statement authenticated by the signature of Professor Schaeffer, of Dusseldorf, may be accepted as good evidence that Mr. Bernhardt has actually arrived at some results of more than ordinary importance—one of which, at least, is, even in this country of high mechanical invention, still a great desideratum, namely, *smoke without soot.* A late distinguished physician (Sir George Tuthill) has left it on record as his deliberate opinion, that the excessive quantity of carbonaceous matter sent forth into the atmosphere of London from its innumerable coal fires is the grand cause of its unhealthiness, as compared with places in its near vicinity.

"The Royal General Post-Office built, many years ago, a factory adjoining the post-house, for the repair of the mail-coaches, and since the building of the diligences and the increase of business, it has become a very large coach manufactory, in which above seventy workmen are at present daily employed. In a building at the back, arranged for the purpose, a forge for ten fires was put up and erected in the usual form. Smoke and soot penetrated into the dwellings of the neighbors, and rendered them uninhabitable and worth no rent. Complaints arose, and an expensive law-suit, which naturally terminated to the disadvantage of the Post-Office department. Experiments were then made to clarify the smoke and separate the soot. The Prussian consul in England—that land of invention—was desired to make inquiries whether any means were known to remedy the evil, but nothing could be done; and the most learned professional men doubted the possibility of an invention to answer the purpose, because it was believed that any attempt to separate the smoke from the soot could only be made at the expense of the draught.

"It became a point of consequence, to the Post-Office authorities here, to satisfy the neighbors at any price, and they endeavored to suppress the nuisance arising from the soot by removing the smithy into an intermediate building constructed for the purpose: the result of experiments by several artists, in inventing an ap-

paratus by means of which it was hoped to banish the soot. A cistern of water was applied over the roof, which was intended, by being placed round the outlet for the smoke, to absorb its heavier parts; but the soot soon covered the water with an incrustation, and the finer particles of the soot escaped from the chimney and covered the gardens of the neighbors; besides the smoke spread itself throughout the smithies, so as to be dangerous and insupportable to the workmen at the fires. At that time the architect, Mr. Bernhardt, of Saxony, was in Berlin, and had been employed in the Royal Palaces; having devoted the whole of his life to the study of the deficiencies at present existing in the construction of fires, he was enabled to correct the similar faults in the General Post-office buildings, and his plans were crowned with the best success. Mr. Bernhardt discovered the means of forcing the draft of the smoke, and separating the soot from it. His plans were carried into execution. *In a short time, without any interruption to the business of the coach factory, the work was completed. The smoke ascends in a purified state through two cylinders of zinc to the roof, and the soot remains in the interior of the three story high building, concentrated in separate channels and chambers for it.*

"It is remarkable to observe the soot depositing itself in coarse particles, and afterwards becoming gradually finer as it ascends; to see the smoke rising through narrow wire nets. In the channels of the five chimneys a mass of $26\frac{2}{3}$ cubic feet of soot was found, after three months' purifying, and which had formerly been mostly conducted over the roof."

BENJAMIN FRANKLIN AND DR. MATHER, of Boston.—The following letter was written by Benjamin Franklin, in 1784, while he was discharging the duties of American Envoy at the court of France. It is so highly characteristic of the man, and so fraught with instruction, that, although it has been often republished before, it is deemed very suitable for the readers of the "Companion"—who will, we are sure, be always pleased to read the writings and sayings of that worthy and great man.

In the last paragraph but one, he speaks of the importance of cultivating kindly feelings between the two nations—a sentiment which has generally pervaded this country, at least so far as it could be done with honor. The closing paragraph contains advice equally applicable to individuals, as to the peculiar condition of this country at that period. Advice which every *young* man, at least, should strive to profit by.

Rev. Sir,—I received your kind letter, with your excellent advice to the people of the United States, which I read with great pleasure; and hope it will be duly regarded. Such writings, though they may be lightly passed over by many readers, yet, if they make a deep impression on one active mind in a hundred, the effects may be considerable.

Permit me to mention one little instance, which, though it relates to myself, will not be quite uninteresting to you. When I was a boy, I met with a book entitled, "Essays to do good," which, I think, was written by your father. It had been so little regarded by a former possessor, that several leaves of it were torn out: but the remainder gave me such a turn of thinking, as to have an influence on my conduct through life: for I have always set a greater value on the character of a doer of good, than any other kind of reputation: and if I have been, as you seem to think, a useful citizen, the public owes the advantage of it to that book.

You mention your being in your 78th year—I am in my 79th. We are growing old together. It is now more than 60 years since I left Boston: but I remember, well, both your father and grandfather, having heard them both in the pulpit, and seen them in their houses. The last time I saw your father was in the beginning of 1724, when I visited him, after my first trip to Pennsylvania. He received me in his library; and on my taking leave, showed me a shorter way out of the house, through a narrow passage, which was crossed by a beam over head. We were still talking as I withdrew, he accompanying me behind, and I turning partly towards him, when he said, hastily, 'stoop, stoop!' I did not understand him, till I felt my head hit against the beam. He was a man who never missed any occasion of giving instruction, and upon this he said to me: "You are young, and have the world before you: stoop as you go through it, and you will miss many hard thumps." This advice, thus beat into my heart, has frequently been of use to me; and I often think of it, when I see pride mortified, and misfortunes brought

upon people by their carrying their heads too high.

I long much to see again my native place; and once hope to lay my bones there. I left it in 1723. I visited it in 1733, 1743, 1753, and 1763. In 1773 I was in England. In 1775, I had a sight of it; but could not enter, it being in possession of the enemy. I did hope to have been there in 1783; but could not obtain my dismission from this employment here: and now, I fear, I shall never have that happiness. My best wishes, however, attend my dear country, "*esto perpetua.*" It is now blest with an excellent constitution; may it last forever!

This powerful monarchy continues its friendship for the United States. It is a friendship of the utmost importance to our security; and should be carefully cultivated. Britain has not yet well digested the loss of its dominion over us; and has still, at times, some flattering hopes of recovering it. Accidents may increase those hopes; and encourage dangerous attempts. A breach between us and France would infallibly bring the English again upon our backs; and yet we have some wild heads among our countrymen, who are endeavoring to weaken that connexion.

Let us preserve our reputation by performing our engagements; our credit, by fulfilling our contracts; and our friends, by gratitude and kindness: for we know not how soon we may again have occasion for all of them. With great and sincere esteem, I have the honor to be, Reverend Sir, your most obedient and most humble servant, B. FRANKLIN.

Passy, May 12, 1784.

[From the Journal of the Franklin Institute.]

Abstract of the Specification of a Patent for a Machine for Moulding Bricks.

Granted to WILLIAM C. GRIMES, of York, in the county of York, in the State of Pennsylvania, December 2d, 1834.

This machine is constructed upon the following general principles. A wheel is affixed horizontally to, and revolves with, an upright shaft, the latter being properly supported above and below by a suitable step and box, in which its gudgeons turn. The moulds in which the bricks are to be formed are placed around and upon the face, or upper side, of the wheel, near its periphery; these may stand in the direction of radii from the centre of the wheel, or otherwise. Two or more moulds may be united or connected together. A hopper, or trough, of sufficient capacity, is placed in an inclined position, with its lower end over one or more of the moulds at a time, as they pass under it. This hopper is to contain the tempered clay of which the bricks are to be made, and though that part of the bottom of it which projects over the mould, or moulds, an opening, or openings, are made of the length and width of a brick, through which the clay is to descend into the moulds. The motion of the wheels is not to be continuous, but intermitting; while it is at rest, a mould is immediately beneath the opening in the bottom of the hopper, or trough, and the clay is then forced by a piston down into it; the piston then rises, and the wheel moves, and the moulds are thus filled in succession. As the filled moulds pass round upon the wheel, they are removed, and replaced by empty ones.

It is manifest that two or more moulds may be filled at the same time, by the use of two or more openings and pistons, and the employment of such other devices as may thereby be rendered necessary, sufficient power being applied for that purpose.

The number of moulds will depend upon the diameter of the wheel, which will admit of considerable variation, but from four to six feet I think the most convenient.

The moulds must be slightly attached to the face of the wheel, which may be done in various ways, the following being among the best. From the under side of the moulds project two dowel pins, which fit into corresponding holes in the face of the wheel, by which means the moulds are kept from any lateral or horizontal movement. The dowel pins should be short, so that the moulds may be readily disengaged from the wheel. The holes for the pins, or dowels, in the face of the wheel, should be pierced through it, so as to prevent them from being filled, or choked with dirt, &c.

Two or more moulds may be united in one frame, as is usual in brick moulds. The frames of the moulds are inclined from each other, like key-stones, so as to stand as radii from the centre of the wheel, thus forming the proper arch or curvature around the wheel, and their upper surfaces should form a true plane. Each frame of moulds has a thin plate,

or board, which is equal in length and breadth to its corresponding frame, and forms the bottom or bed of the moulds. The aforesaid dowel pins pass loosely through holes made for the purpose in this plate; the latter not being otherwise fastened to the moulds, its use will be apparent to any one acquainted with the usual mode of moulding bricks.

The machine may receive its motion by a strap, carried around the fly-wheel, and over a drum, or pulley, which last may be driven by any competent power; or the machine may receive its motion by a crank attached to the fly-wheel shaft, or in any other convenient mode.

I do not mean to confine myself to the particular form or arrangement of the parts as before specified, but to vary them as experience or convenience may dictate, whilst the general principle remains unchanged.

What I claim as new, and as my invention, and for which I ask letters patent, is, 1st. The moulding of brick upon, or in moulds upon, the face of a revolving horizontal wheel, disk, or rim, constructed and acting upon the principle herein specified.

2d. The manner of forcing the clay into the moulds, by the combined action of a feeder and piston.

3d. The general construction and combination of the respective parts of the above described machine, from which general combination it derives that character by which it will be readily distinguished, by any competent machinist, from the various machines for moulding bricks already in use.

And I do hereby declare that I do not intend to claim as my invention, the piston, cranks, hopper, or any other part of the said machine, taken separately and individually, as these may constitute the elements of other machines; but, as aforesaid, the construction and combination of these parts upon the principle by me devised, and herein fully exemplified.

WILLIAM C. GRIMES.

The foregoing comprises about one-half of the specification, the remainder generally referring to the drawings. The same remark will apply to the next patent, and also to those for making nails. The machines manifest much ingenuity, and an account of their performance, when completed, has been promised, which, if satisfactory, will appear in the Journal. —[ED. J. F. I.]

Abstract of the Specification of a Patent for a Machine for Pressing Bricks. Granted to WILLIAM C. GRIMES, of York, York county, Pennsylvania, December 2d, 1834.

The general principle of the construction and operation of this machine is briefly as follows.

Upon a vertical shaft, or spindle, is fixed a wheel, disk, or rim, of sufficient size, which is to revolve horizontally. In the upper face of this wheel are a number of holes, or mortises, which are the moulds in which the bricks are to be pressed. The bottoms of these moulds are not a fixed portion of the moulding wheel, but are the upper faces of movable pistons, that slide up and down in the moulds, as the wheel revolves. The rods, or posts, which support and guide the pistons, descending vertically from them. The lower ends of the piston rods, or posts, slide round as the wheel revolves, upon a circular horizontal platform, or rim, or rather upon two platforms, one-half of the circle, or thereabouts, being elevated above the other about two or three inches. When the pistons rest upon this elevated portion of the circular rim, or platform, their upper faces are flush with, or above, the upper surface of the wheel; hence the bricks which have been pressed, being thus raised, can be removed with facility; while upon the opposite side of the wheel, the pistons upon the lower portions of the rim have their upper surfaces sunk down within the moulds, leaving cavities into which the bricks are dropped, as the pistons are depressed, the motion of the wheel, which is intermitting, not being too rapid for that purpose.

Just before the pistons rise on to the elevated portion of the circular rim, they pass under the short end of a strong iron lever, which projects over the face of the horizontal moulding wheel, far enough to cover the moulds as they pass under it. The level receives a continuous motion from a crank and shackle bar, the latter being jointed to the opposite, or long end, of the lever. The crank is regulated and assisted by a heavy fly-wheel, in

passing that point in which there is the greatest resistance to its motion.

While a brick is being pressed by the short end of the lever, the moulding wheel is at rest, as it receives its motion by a pall, or movable hand, that has a vibratory or reciprocating motion, which it receives from a crank fixed for that purpose on to the end of the fly-wheel shaft.

The horizontal moulding wheel may be of iron, and cast in one entire piece, of such thickness as may be necessary to its strength, the requisite depth of the moulds being formed by a flanch, rim, or projection, standing out upon the face of the wheel, the said rim, or flanch, making the sides and ends of the moulds. The moulds being in a circle, are placed as near to the periphery of the wheel as a proper thickness of metal will allow; the inner ends of the moulds may approach very near to each other, leaving only sufficient strength of metal between them; hence it may be seen that the number of moulds in the face of the wheel will depend entirely upon its diameter, which may be very much varied, but from three to six feet I think the most suitable.

The moulding wheel, pistons, horizontal rim, and fly-wheel, should consist of cast iron, and, in fact, the whole machine should be made of metal.

Motion may be given to the machine by a strap, carried round the fly-wheel, or by the crank attached to the end of the fly-wheel shaft, which may project beyond its bearing for that purpose.

I do not mean to confine myself to the particular form and arrangement of the parts as before specified, but to vary them as experience or convenience may dictate, whilst the general principle remains unchanged.

What I claim as new, and as my invention, in the above described machine for pressing brick, and for which I ask letters patent, is—

1st. The revolving horizontal wheel of moulds, constructed in the manner, or upon the principle, herein described, in which the processes of putting in, pressing, and removing the bricks from the moulds, are all done at one and the same time.

2d. I also claim the revolving pistons, as connected with the revolving moulds, and operating in the manner, or upon the principle, set forth in the foregoing specification.

3d. I also claim the employment of the stationary rim with a double platform, for raising and depressing the pistons, as before described.

4th. I also claim the scolloped rim, or flanch, for the purposes hereinbefore set forth.

5th. I also claim the pressing of brick by means of a lever, operating, and operated upon, as herein shown.

6th. I also claim the general construction and combination of the respective parts of the above described machine, from which general combination it derives that character by which any competent machinist will readily distinguish it from any of the brick pressing machines previously in use. But I do not claim the pistons, fly-wheel, shafts, or any other part, taken individually, as these may constitute the elements of other machines; but, as aforesaid, the construction and combination of these parts upon the principle by me devised, and herein fully exemplified. WILLIAM C. GRIMES.

On Various Modes of Imitating Bronze, translated from the Dictionnaire de l'Industrie Manufacturiere Commerciale et Agricole; Article, Bronzage. By M. H. GAULTIER DE CLAUBRY. [Translated for the Journal of the Franklin Institute by Wm. W. Smith, at the request of the Committee on Publications.]

A bronze color, varying according to the nature of the substances used to produce it, and approaching more or less to the natural tint, is given to many articles of plaster, wood, paper, or pasteboard. A very brilliant bronze is produced by gold leaf rubbed on a muller, with honey or gum; goldbeater's clippings are used for this purpose. *Aurum musivum* may be employed for the same purpose; one part of this, and six of calcined bones, must be finely pulverized; a small quantity is taken on a moistened rag, rubbed over the article to be bronzed, which is then scoured with a dry piece of linen, and submitted to the burnisher.

When aurum musivum is to be fixed on paper, it is powdered without the calcined bones, and mixed with the white of eggs, or a light varnish of alcohol; this mix-

ture is applied with the brush, and the article is afterwards burnished.

When a plate of iron is immersed in a diluted and boiling solution of sulphate of copper, the copper is precipitated in the state of a powder, which can be easily washed by agitating it with water. This powder, mixed with six times its weight of calcined bones, also in fine powder, may be substituted for the preceding mixtures.

It is sometimes desirable to give articles a grey color, nearly resembling that of iron; this is called white bronze; it is produced by several methods. Argentum musivum gives a very pretty tint; tin reduced to an extremely fine powder, (by pouring it, while fused, into a box, the interior of which is well covered with pulverized chalk, and shaking until perfectly cold,) is also used. This powder, sifted and mixed with a solution of glue, is applied to the article, which takes a dull color; if brilliancy is required, the burnisher must be employed.

Argentum musivum is an amalgam of equal parts of bismuth, tin, and mercury.

When plaster is to receive the white bronze, it is rubbed with plumbago.

Well cleansed cast iron, dipped into a weak solution of sulphate of copper, becomes coated with copper, which adheres to its surface; under these circumstances the copper assumes a reddish hue, which passes to yellowish brown.

Bronze, exposed for some time to the action of the atmosphere, is covered with a very thin coating of carbonate, which gives it a green hue, known by the name of "patine antique." Imitations of this tint have been attempted in various ways; but however great may be the resemblance of these artificial colors to those produced by time, there are still certain characteristic shades, which a practised eye can easily detect; the antiquary should not, therefore, complain, since it is always possible for him to distinguish an "antique" from an imitation.

The hue of antique bronze is given to bronzed articles intended for house ornaments, or to medals, by treating their surfaces with different compounds. A great number of these mixtures have been recommended; many of them answer sufficiently well, but the beauty of the product depends very much on the manner of applying them, for different workmen, using the same composition, obtain very different tints.

We will here merely enumerate some mixtures with which our best workmen produce handsome colors. The metal having been well scoured with nitric acid, the compound is very uniformly spread over its surface with a proper linen roll, or brush.

The bronze color obtained, whatever may have been the mixture employed to produce it, will depend on the nature of the alloy: since the alloys used for casting the ornamental articles which are to be bronzed vary, it follows, of course, that the same bronzing mixture, applied in the same manner, cannot in all cases produce the same tint.

Nitric acid diluted with two or three parts of water is rubbed over the metal; the color is at first greyish, but soon becomes greenish blue.

A solution of one part sal ammoniac, three carbonate of potash, six of common salt, and eight nitrate of copper, in twelve parts of boiling water, is rubbed at intervals on the metallic surface; the tint is unequal and harsh, but it softens, and becomes more uniform.

A beautiful greenish blue bronze may be obtained by washing a copper surface with concentrated aqua ammoniæ, for a sufficient length of time.

The base of nearly all the compounds employed is vinegar and sal ammoniac. Thus, skilful workmen use nothing but a mixture of sixty grammes* of sal ammoniac, and a litre† of vinegar.

Another mixture, which gives good results, is composed of thirty grammes of sal ammoniac, eight grammes of salt of sorrel, and ten litres of vinegar.

An experienced chaser of Paris uses a mixture of 15 grammes of sal ammoniac, 15 grammes common salt, 30 grammes spirit of hartshorn, and 1 litre vinegar.

One litre of vinegar, 15 grammes of sal ammoniac, 15 grammes of common salt, and 15 of ammonia, form a good mixture. A soft brush is dipped in the mixture, and the article is rubbed with it until it takes a handsome bronze tint; the piece should be barely moistened, and

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* A gramme is equal to 15.4 grains.

† A litre equals 1.76 imperial pint.

any excess of liquid should be removed by another brush. If, after two or three days, the tint is found to be too pale, the process is repeated. The work may go on in the air, the color takes better; the copper need not be heated.

The two following compounds produce a handsome effect:

Eight grammes of sal ammoniac, 8 grammes of common salt, 16 grammes of ammonia, one half litre of vinegar.

Two grammes of salt of sorrel, eight grammes of sal ammoniac, one fourth litre of vinegar.

The mixture is applied with a brush which is almost dry, and the operation is continued until the desired tint is obtained. These compounds produce a better color when the process is conducted in the sun.

Medals are colored in a different manner; they are immersed in a liquid the composition of which varies much.

Five hundred grammes of powdered sub-acetate of copper are thoroughly mixed with 333 grammes of sal ammoniac, also in powder; make a paste of this, with one part of a glass of vinegar. Take a piece of paste of the size of a walnut, mix it with the remainder of the vinegar, and a litre of water; boil it for a quarter of an hour; allow the solution to repose, and decant the clear liquid. To bronze medals, pour some of this boiling liquid over them, continue the ebullition for five or six minutes, decant the solution, and wash the medals perfectly clean. The same liquid cannot be used more than five or six times; at each time, a quarter of a glass of vinegar must be added. The process must be carried on in a copper pan; the medals are to be fixed on small blocks of wood, so that they cannot come into contact with the pan, or with each other.

The medals should be well wiped immediately, that the tint may not change; then dried with care, and subjected to the burnisher, to render them bright.

It almost always happens that some of the pieces take a bad tint; very often some are spotted.

A mixture of 510 verdigris, 250 sal ammoniac, rubbed with vinegar on a marble slab, and transferred to well closed vessels, is used in the same way; a piece is added to a glass of vinegar, and two litres of water, and the whole boiled for ten or twelve minutes.

A good bronzing mixture for alloys of lead and tin, consists of 100 parts of nitrate of copper, perfectly pure and neutral, in a solution at 18° of Baume's hydrometer, and 20 parts of sal ammoniac; this liquid must be applied so as to wet the metal as little as possible.

We will here detail the Chinese process of bronzing, as it is a curious one:

The copper is washed with vinegar and ashes, until it becomes perfectly bright; it is dried in the sun: 2 parts verdigris, 2 cinnabar, 5 sal ammoniac, 2 duck's bills and livers, and 5 alum, are to be finely pulverized and well mixed; a liquid paste is made with this mixture; the copper is covered with the paste; it is then heated, allowed to cool, and the paste removed; this is repeated eight or ten times. The copper assumes a pretty tint, which is so durable that the action of the air and rain does not impair its beauty. A mixture of 1 part of sal ammoniac, 3 cream of tartar, 3 common salt, 12 hot water, and 8 of a solution of nitrate of copper, gives a good bronze. By increasing the quantity of common salt, the color becomes clearer, and approaches to yellow; by diminishing the proportion of the same, or omitting it altogether, different shades of blue may be produced. The action is increased by adding a greater proportion of sal ammoniac.

Certain articles are bronzed red by coating them with oxide of iron, and exposing the pieces to heat; the same tint may be given by rubbing them with a liquid containing one-thirtieth of sulphuret of potassium; the color readily changes to greenish brown.

Gun barrels are bronzed by being rubbed with fused chloride of antimony; this must be repeated several times. To obtain a successful result, the barrels must be gently heated.

MM. d'Arcet and Thenard proposed a cupreous soap, with which, when plaster is impregnated, it assumes so much the tint of ancient bronze as to deceive the eye, and its real character can only be ascertained by touching it.

Pure linseed oil is converted into a neutral soap by caustic soda; to this a strong solution of common salt is added; and

the whole is boiled until the liquid has a great specific gravity, and the soap swims at the surface in small grains; the solid matter is to be drained and pressed, to rid it as much as possible of the fluid; dissolve this soap in distilled water, and pass the solution through linen; dissolve also in distilled water, 80 parts of sulphate of copper, and 20 parts of sulphate of iron; filter, and into the latter solution pour the solution of soap, until decomposition is complete. A little sulphate is now added, and the whole stirred several times at intervals, and then boiled; in this way the soap is mixed with an excess of sulphate. It is washed first with a large quantity of boiling water, next with cold water, and thrown on a linen, pressed and dried as much as possible.

Boil a kilogramme (2.2 avoird. lbs.) of pure linseed oil with 250 grammes of pure finely powdered litharge; strain through a linen, and allow the oil to stand in a stove; it clarifies much better there.

Fuse together in a delft-ware vessel, on a steam or water bath, 300 grammes of boiled linseed oil, 160 soap of copper and iron, 100 pure white wax, and keep the mixture melted some time, to deprive it of moisture. Heat the plaster in a stove to 80° or 90° Centigrade, and apply the fused preparation; when the plaster has become so cold that the mixture will no longer penetrate it, it is again placed in the stove and heated to 80° or 90° Cent.; more of the mixture is applied, and this operation is repeated until the plaster has absorbed enough; it is then again placed in the stove to deprive its surface of color; the porosity of the plaster is such that the mixture penetrates it without leaving the finest lines soft, and this result is obtained by no other method; the depth to which the preparation sinks is greater or less, according as the piece has been placed a greater or less number of times into the stove.

When the article has absorbed a sufficient quantity of the soap, and has taken the required tint, its surface is gently rubbed with a bunch of cotton, to give it the necessary brilliancy, and if it is desired to imitate natural bronze exactly, a small quantity of shell gold is applied to the raised parts. It sometimes happens, that flaws and other defects render it necessary to insert a piece in statues; the tint of these pieces never exactly resembles that of the surrounding bronze; this effect is perfectly imitated by cutting out a piece of plaster, and running some other plaster into the cavity; the tint of the replaced part differs from that of the mass, and resembles exactly the defect in real bronze.

This process affords the means of obtaining articles of plaster, resembling very closely those of real bronze; medals, busts, and even statues, may be finished in this way, provided a stove of suitable dimensions can be procured; the process presents some difficulties, and to these many have yielded; we will mention them for the sake of those about to engage in this art, to show them the faults of others, and furnish them with the means of surpassing their predecessors. It should first be stated, that, with proper care, this process affords most satisfactory results. M. d'Arcet himself prepared some articles which were taken for bronzes of superior beauty by skilful artists; the same success may attend operations on a larger scale.

When the plaster is moistened unequally, it does not absorb the soap uniformly, because the porosity of the parts is not equal; the consequence is, that the surface takes various tints; when the pieces are small, this defect need not be feared; but when they are busts, or castings of large size, it frequently happens that contiguous parts take very different shades of color, and spots will sometimes be perceived, very slightly, if at all, altered by the process.

The occurrence of these blemishes may be avoided by carefully casting the pieces to be bronzed, expressly for this purpose, and ascertaining by a few trials what quantity of water must be used, in order that the cast may assume the finest shade; with these precautions the process may be conducted successfully, even on a large scale.

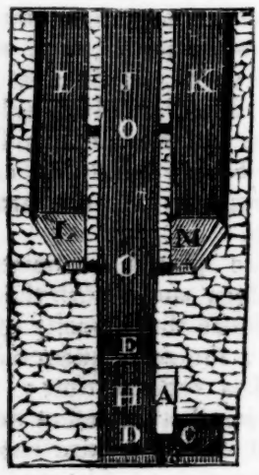
The small pieces are dipped into the melted compound, then shaken, and dried on one side to cause the absorption of the composition remaining on the opposite surface; this may also be accomplished by exposing the surface to a bright fire. A gilder's chafing dish must be used for large articles.

A variety of articles, such as time-pie-

ces, vases, &c. may in this way be manufactured, which resemble very much handsome ornamental bronzes, and can be sold at low prices; it is only surprising that this art is not cultivated to a greater extent, as these ornaments might, by a little perseverance, be introduced into general use. Plaster finished in this manner may be exposed to air, moisture, or even rain, without being injured.

[From the Journal of the Franklin Institute.]

Abstract of a Specification of a Patent for a Furnace for Preparing and Smelting Iron Ore, with Anthracite Coal. Granted to THOMAS S. RIDGWAY, Pottsville, Schuylkill county, Pennsylvania, December 17, 1834.



The hearth of the smelting furnace, or stack, as seen in the section, letter J, may be in the usual form of smelting furnaces, and receive the blast at one or more openings in the bellows wall, made for the purpose, excepting the wind wall, opposite the blast, marked letter H, which is at an angle of forty-five degrees, or thereabout, and extending up the said wall of the stack to the bottom of a door or opening, letter E, made for the purpose of rendering the fire manageable; this door will be placed in the stack at the top of the smelting fire, which will be from four to six feet high above the hearth, that being about the maximum height that a blast can be forced through anthracite coal; whereas the usual height to which it is forced in a charcoal furnace is thirty-five feet.

Another stack, marked I, in the section, to be charged or loaded with anthracite coal, and kept hot by caloric received from the smelting stack by means of one or more openings in the wall of the smelting stack, opposite O, marked in the draft, at a convenient height above the smelting fire, or by means of a separate fire, as the case may be; the intention of this operation is to dissipate sulphur from the coal, and keep it in a proper state of heat for the smelting fire, without useless consumption of fuel. At the bottom of this stack is a door for the purpose of taking out the coal, after it is prepared to put on the smelting fire.

The purifying and carbonating stack, oven, or chest, marked K in the draft, may be attached to the smelting furnace, or be apart from it, and receive caloric or heat from the smelting furnace, by one or more apertures in the wall of the smelting stack, opposite the letter O in the draft, or by a separate fire. This stack is to be loaded or charged with iron ore and anthracite coal, or charcoal, for iron ore and charcoal, together with the proper fluxing materials, as may best prepare the ore before it is put on the smelting fire. There is a door in the bottom of this stack, for the purpose of taking out the ore after purification. This indispensable operation of carbonating the ore cannot be performed without heat, in the absence of oxygen, nor can it be performed in the usual way, owing to the great specific gravity and slow combustion of anthracite coal; whereas, in this way, only a very small quantity of charcoal will be required to purify and carbonate a ton of ore.

What I claim as my own invention, is the carbonating stack, oven, or chest, and also the stack for preparing the anthracite coal, and relieving the smelting fire of the great burthen of ore and anthracite coal requisite in the usual way of smelting; also the inclined wind wall, which renders the smelting fire so manageable that it may be stirred as often as required; and, lastly, the combination of the above three stacks. These may be built of stone, or any good, durable material, and of any convenient size or capacity, suitable to the power of the blast, with valves at the tunnel heads, or top, to regulate and direct the heat from one stack to another.

THOMAS S. RIDGWAY.

[From the Farmers' Register.]

On Price—the Causes and Effects of the Fluctuations considered, and the Principles maintained applied to the Present Rage for Speculation. By THOMAS R. DEW, Professor of Political Economy, &c., in the College of William and Mary.

[The following communication was intended by its author to appear anonymously —and it may be observed that its form still accords with that intention — though we have obtained permission to give the author's name. This mark of its origin was desirable, not only for reasons which are sufficiently obvious, but also because the facts treated of are in some degree effects of the causes considered by the same writer in his "Essay on Usury," in Vol. II. of Farmers' Register — and the reasoning of the two communications have a corresponding connexion.

The exhibition of the principles which constitute *price* in general, and the investigation of the causes of unfounded and ruinous fluctuations, may be serviceable to the agricultural community at this time, when there is every indication of the approach of one of those fits of national delusion or madness, such as occurred in the time of non-specie paying banks in this country, and such as every commercial country is sometimes liable to suffer from.

In addition to the close connexion of this and many other subjects of political economy with agricultural interests, we find ground for especial approbation of Professor Dew's manner of inculcating his doctrines, by showing their bearing on current events, and offering tests of their truth, in accessible and striking practical proofs. Without resort to some such mode of attracting attention to what is generally (though incorrectly) deemed a dry and repulsive study, the abstract truths of political economy will continue unknown to governments and to nations, long after having been established and undoubted in the opinions of reading men. Thus Adam Smith's exposure of the restrictive (or commercial) system of Europe had delighted and convinced the learned and literary community for half a century before it had any effect on the action of the British government, and his admirable work had long been a text book in the colleges in the United States, while our legislators still continued to act in defiance of its truths, on questions of national policy, and in accordance with the notions on trade of the past ages of darkness and ignorance.

Having thus expressed general approbation of the author's views, it is proper to mention an exception — which expression of dissent would otherwise be uncalled for, and unnecessary. It relates to the effects anticipated to Virginia from the present high price of slaves. That such consequences, whether immediate or remote, will follow, we have not been convinced by the author's argument.—ED. FARM. REG.]

But a little while since, as we all but too well remember, the country was plunged into the utmost distress from want of money, lowness of prices, and failure of credit every where; now we seem to be fast rushing into the opposite extreme—money is becoming very plentiful, prices have almost doubled, and commercial credit seems every where re-established. A speculating mania has been generated in our large commercial cities, and seems rapidly spreading itself through our country. If then this be a season of prosperity, it is one of hazard likewise. Now is the time for the exertion of that prudent foresight and calm deliberation, which alone can carry the man of wealth safely through those great and sometimes rapid fluctuations of prices, always attendant on the rage for speculation. I propose briefly in this communication to point out the operation of those causes which are calculated to make money plentiful or scarce, (as it is commonly termed,) and to show their operation on prices at this moment. This investigation cannot, I think, fail to be interesting at this time, and I hope will call forth the speculations of others much more competent to do justice to the subject than myself.

Circulating Medium.—The first subject, undoubtedly, to which we must turn our attention in an investigation of this kind, is to the currency. What is the currency? What are the items which compose it? Every thing which passes from hand to hand, and will perform the function of money, must be regarded as currency. First then come the gold and silver coins, and bank paper; these of course form a part of the circulating medium, but not the only, or even the greatest or most important portion. Bonds, promissory notes, scrip notes, bills of exchange, stocks of every description, form likewise a portion of the circulating medium. All of these pass from hand to hand, and represent value, and therefore perform the functions of money. For example, I buy a tract of land, for which I give $10,000, and pay for it by passing to the seller ten bonds of a thousand dollars each. Now this exchange is effected without a single dollar of real money, merely by the agency of credit: in the same way I might have paid for it in stocks, or by giving bills of exchange, &c. But although these are to be looked on as circulating medium, it is evident that equal

quantities of them will not perform as many exchanges as money; for the value of money is well ascertained—it bears no interest whilst in our hands, and therefore it circulates rapidly and effects many exchanges: whereas the value of bonds, promissory notes, bills of exchange, stocks, &c., have a value more indefinite; and most of this species of paper, too, bears an interest while in our hands. Its circulation is therefore comparatively sluggish, in consequence, first, of the difficulty of fixing its value; and second, because we make a profit on it whilst lying in our hands, and therefore are in no hurry, generally, to get rid of it. But although this portion of the circulating medium be greatly inferior to money in the performance of the functions of circulation, yet it much more than makes up for this deficiency, by the vast amount of it which is in circulation. In England, for example, it has been computed that the bills of exchange alone in circulation are ten times more in amount than the whole money in the country: while the latter is estimated at £40,000,000, the former reaches the enormous aggregate of £400,000,000. In our country, the Bank of the United States alone does a business in exchange amounting in the year to more than $250-,000,000; while its own paper in circulation has never reached one capital, or $35,000,-000. Now, the bonds or promissory notes of individuals may be looked on as rising, in amount, infinitely beyond the aggregate of the bills of exchange and money together. Comparing then all the items of the circulating medium, *exclusive* of money, with the money, we shall be astonished to see how insignificant in quantity the latter is, when compared with the former. The fact is, money performs but few of the exchanges of society, by actual passage from hand to hand. "In England," says Mr. Wade, "by the use of bills of exchange, bills of lading, checks, scrip notes, clearing houses, and a variety of other contrivances, aided by a vast fabric of credit taken and given in open account, money (in its common acceptation) hardly ever enters into mercantile affairs; it is the substance really meant and shadowed forth; but it rarely, as one may say, bodily passes from hand to hand." In our own country, every one, too, must have observed how rarely the exchange of large masses of property are effected by the intervention of money. In the great majority of cases, the property is paid for by the passage of bonds, bills of exchange, stocks, &c. and but a small portion by actual money. Hence what are called cash sales, if too frequent all of a sudden, in a particular neighborhood, even in times of great prosperity, will cause the property to be sold at a sacrifice, because of the great difficulty of commanding the actual money to make the purchase.

Effect of Rapidity of Circulation.—Having thus explained my notion of the components of the circulating medium, and shown that money is vastly inferior in amount to all the other items combined, let us now look a moment to the effect produced on the circulating medium by a rapid or sluggish circulation. And it is very evident, that while the quantity of the currency remains the same, its apparent amount and real efficacy may be either increased or diminished, merely by an increase or diminution of the rapidity of circulation. For example, $10 passing through ten hands, in the course of the day, will accumulate as much property as $100 passing only once from hand to hand. Now, supposing the whole circulating medium to remain stationary in amount, but that the rapidity of its circulation is suddenly doubled throughout the whole country, then its *apparent* amount and its *real* efficacy would be doubled likewise. With the help of these incontrovertible principles, let us now proceed to examine into the effect of the late money pressure in the United States: 1st, On the rapidity of the circulation—and 2dly, On the amount of the circulating medium.

1st. *Effect on Circulation.*—I shall not pretend to enter into an investigation of the causes which produced the late pressure in the money market. The nation has already been fully and completely enlightened upon this subject, by men whose minds can compare with any which the world can furnish. Moreover, it would require me to enter more fully into the field of politics than would be agreeable to myself, or suitable to an agricultural journal. Suffice it to say that the pressure did every where take place; that a general difficulty of procuring money existed throughout the country; that prices, for a season, fell every where; and that confidence and credit for a short time, in the great commercial towns, were almost entirely destroyed. First let us see the effects of all this on the exchanges in society, and then on the rapidity of circulation in the currency.

During a pressure of the kind just spoken of, the loss of confidence and fall of prices force a great deal of real and other property in the market, to be sold for payment of debts, which ordinarily remains stationary in the hands of its owners. Lands, houses, negroes, stocks of goods, &c., are thus forced to change hands, and of course increase the exchanges. Perhaps the sinking of prices generally may have a tendency to diminish the sales of the annual pro-

ducts of the soil, such as corn, wheat, tobacco, and sugar; but not of cotton, for the foreign market is the regulator of the price of this very important article. Hence it may be said, that a money pressure at first has a tendency, by the great quantity of property forced into the market for sale, rather to increase, than diminish the number of exchanges. Whilst, however, the number of exchanges increase, the circulating medium suddenly becomes much more sluggish, taking the whole aggregate, in performing the functions of circulation. The great capitalists, who are in the habit of purchasing produce with a view to sell with a profit, when prices are falling, rather keep aloof from the purchase of raw produce, least a further fall may injure them—their capital then circulates more slowly, and in consequence of it, the annual productions of the country are not distributed with that regularity, and adaptation to the various wants of the community, as under ordinary circumstances. The body politic, in this situation, is like a patient suffering congestion in one part of the system, while there is a depletion almost to the loss of vitality in another.

Again: bonds, bills of exchange, &c., ordinarily performing the larger portion of the circulation of every country, have now a much slower circulation, and consequently less efficacy in effecting the exchanges; because as there is a general loss of confidence and credit, A, who has sold to B, is distrustful of his bonds, his bills, in fine of credit in every shape — he wants money. Money too has generally a sluggish circulation on such occasions, for every one getting possession of it, is disposed to hold it as long as possible—hard money seems to be almost the only true friend which one can get hold of in such times as those, and is consequently held with a miserly grasp. Persons will not venture it out without the best security, and on high rate of interest, obtained either directly or indirectly.*

Thus we find, first, that the number of exchanges has a tendency to increase during the first operation of a money pressure; and second, that the whole circulating medium of the country suddenly, from the very same cause, diminishes in the rapidity of its circulation, and therefore becomes less efficacious, as I have already proved.

2d. *Effect of money pressure on actual amount of circulating medium.*—Let us now examine into the state of the circulating medium, and see whether, during a money pressure, it has any tendency to increase in quantity, so as to counteract the operation of the causes above specified. It is evident, first, that the money has no tendency to increase in quantity; because, first, the banks are distrustful of the credit of individuals, and of one another; the curtailment forced on one communicates to another, and finally all are obliged to curtail their accommodations and issues—hence a decided diminution in bank paper. Secondly, gold and silver in actual circulation diminishes in amount, because of the universal disposition to hoard, in consequence of loss of confidence. Thirdly, bonds and bills of exchange will generally diminish in amount, because these depend on credit altogether, and the first effect of the pressure is the destruction of confidence, and the ruin of the whole fabric of credit. Fourthly, stocks of every description diminish in value, or are entirely destroyed, by the disastrous operation of the times. Money, and not stocks, is what the times call for. And thus do we see, that while the exchanges increase, the circulation of the currency grows sluggish, and the quantity in actual circulation rapidly diminishes.

Combined effect of these causes.—What then, let me ask, is the effect of the combined operation of an increase in the number of exchanges, greater sluggishness in the circulation, and diminution of the whole circulating medium? Most undoubtedly, a continued fall in prices, until certain causes are thrown into operation, which will counteract this downward motion. Mr. Hume, in his History of England, says there is a point in the depression of nations, in the scale of circulation, below which they cannot sink. Amelioration will then spring out of the very disorder itself. So I would say in the disasters of trade and agriculture, there is a certain point of depression below which they cannot go. The self-sustaining energies of commerce are called into play, and apply the healing balm without the interference of government. Thus the causes, whose operation I have just been considering, gave a downward motion to prices in our country, until they reached that point which made this one of the worst markets in the world to sell in, and one of the best to sell from. The effect of this on foreign exchange will readily be perceived. More commodities were exported than imported. A money balance was created in favor of the nation. Hence a rapid and full current of the metals was soon seen flowing steadily into the country, and supplying the vast deficit in the circulating medium, occasioned

* An inconvertible bank paper is never hoarded in this manner. It is like fire in each man's hands, he wants to get rid of it as speedily as possible, lest it may be caught on him at a still lower point of depreciation. Hence the inconvertible paper of the Bank of England, in 1797, soon relieved the money pressure, but only to bring on evils greater still, as an inconvertible paper always will do.

by sluggishness of circulation, and diminution of the quantity, from general destruction of confidence and credit. We all very well recollect that, a short time since, almost every paper announced the fresh arrivals of cargoes of gold and silver—and we know that, at this moment, we have more foreign coins in circulation than have been seen in the country for years past. The banks too seem generally to have drawn to their vaults large portions of the precious metals.

Effect of importation of precious metals, and of a restoration of confidence.—Now, whilst the importation of the metals from abroad is gradually adding to the circulating medium, and therefore partially relieving, by this means, the pecuniary distresses of the country, the number of exchanges in society occasioned by forced sales will of course have a tendency to diminish, because those sales will become less and less frequent, after the violence of the storm has already prostrated all that could not stand against it. Affairs will soon settle down to this new state of things. Many of the wealthy men of the former epoch find themselves bankrupts at the commencement of the new—others again, who could command a little ready cash during the crisis, find they have suddenly become wealthy. From this point, the operations of commerce once more begin to extend themselves. Confidence is gradually restored, and with it the credit system begins to be built up again, and the large accession of money from abroad makes the money market much easier than before. The effect of all this is at first to raise prices gradually, and then more rapidly, as a spirit of speculation is generated. When prices are sinking, the spirit of speculation sinks likewise, because each individual is fearful of purchasing, lest he be injured by a farther fall in prices. The credit system likewise is greatly contracted, because the rapid fall in prices, and the frequent bankruptcies occurring from day to day, destroy the confidence of man in man.

Now a rise in prices is accompanied with effects the reverse of these. 1st, The credit system becomes instantly enlarged. When prices are rising all are on the alert: the energies of man are drawn forth; his hopes, which ever have an undue influence, are thrown into play, and the imagination spreads enchanting schemes and projects before him; he is disposed under those circumstances to rush into business, or to get possession of property, whose enhancement in value from the rising tide of general prosperity, is alone expected to make him wealthy. The borrower now can much more easily get money on loan than before, because general confidence is restored, and the constant rise in prices makes property a good security, which before would have been deemed very inadequate. Buying and selling too, under these circumstances, will generally be on credit more and more extended in proportion to the restoration of confidence. Now the immediate effect of the extension of credit, and the increased velocity given to the circulating medium, is to produce a superabundance of money. For, recollect, I have previously shown that sluggish circulation and the destruction of the credit system generated an extraordinary demand for money, which flowed into the country through the medium of importations. The increased velocity of circulation and the re-establishment of the credit system have just the opposite effect, viz. to increase the apparent amount and the real efficacy of the whole circulating medium. Now, when we reflect that the currency has received immense additions during the money pressure from abroad—that the portions hoarded by individuals are thrown into circulation as soon as the panic subsides—that the banks which have rode through the storm are beginning to increase their business and push out their paper, and thus add to the circulating medium—that the United States' Bank has recovered from the shock which it sustained by the removal of the deposites, and is consequently enabled to do a more liberal and extended business, thereby enabling other banks to enlarge likewise—we are not to wonder, under these circumstances, that we have a redundant circulating medium; especially, when we recollect that this increased currency is circulating with greatly increased velocity: and the effect of these combined causes must be a vast enhancement of prices, and a consequent rage for speculation. I will exemplify this by a very simple illustration. Let us suppose a particular neighborhood, whose exchanges, in ordinary times, are effected by $1000. Now I have shown, if any causes operate to make the circulation only one-half as rapid as the ordinary circulation, then the $1000 will not appear to our little district to be more in amount, or in real efficacy, than $500. In this state of things, throwing out of view all other causes, prices in the neighborhood supposed would fall to half their former amount. Now, let us farther suppose that this fall in prices should cause an importation of $500 additional into the neighborhood, and that the rapidity of circulation was again restored, do we not clearly see that we should have a currency redundant by $500? And this would not only, on the great principle of supply and demand, carry up prices to their former level, but would increase them, in the case supposed, fifty per cent. beyond

that level. Now what I have been saying here of a neighborhood, may with equal propriety be said of a whole nation. Let us suppose, for example, the circulating money of this country to be $100,000,000, in ordinary times; that the circulation becomes suddenly only one-half as rapid as before; then the whole $100,000,000, even supposing the quantity kept in circulation undiminished, will perform no more exchanges than $50,000,000 would with the former rate of velocity in the circulation. Prices then would generally sink to half their former amount; money would flow in, let us suppose $25,000,000; and immediately afterwards, the restoration of confidence, and the consequent re-establishment of the credit system, would communicate to the circulating medium the same velocity as before: you would then have a redundancy of twenty-five millions of dollars, and a consequent rise of prices at least twenty-five per cent. upon the principle of supply and demand alone. But the probability is, prices would rise greatly beyond this point, in consequence of the effect produced by a speculating mania—for when prices are rising, every one wants to purchase. Few are capable of reasoning upon the causes; hence an artificial competition is generated among the buyers, and property rises greatly beyond what it should do, upon the principal of actual supply and efficient demand. The reason of man on these occasions seems to be completely unhinged. He looks forward to the realization of wealth by changes in the price of property which he holds in his hands, and almost every one is disposed to turn speculator. And this speculating mania is generally first felt in regard to stocks, whose value is ever fluctuating, and therefore liable to the most sudden impulses, upwards and downwards. I understand at this moment the stock-jobbing spirit to the north has risen to a most extraordinary height. A gentleman, under date of the 28th April, writes me from Philadelphia, that railroads and canals are the order of the day there—that the papers scarcely find room for politics. He says, "two subscriptions have been opened for canals since I came here. The whole stock for the first was taken in thirty minutes. In the second, the whole stock was taken by the commissioners before the doors were opened. A rush and disappointment followed. Millions could have been taken," &c. All this arises from restored credit; from throwing suddenly the hoarded portions of money into circulation—from increased velocity of circulation—from issue of banks, &c.: all of which have contributed to make currency redundant, prices exorbitant, and the spirit of speculation wild and reckless. When I saw certain politicians congratulating the nation upon fresh arrivals of gold and silver a short time since, I could not but reflect upon the shallow knowledge of political economy which such congratulations proved. The influx of gold and silver was the clearest proof that could be furnished, of the general distress of the country; of the loss of confidence and credit; and of the stagnation of trade and the circulation. The importation of the precious metals could only be effected by parting with a large portion of our wealth; and as soon as a sound currency and circulation could be restored, this newly acquired portion was to be entirely redundant, and even mischievous in its operation, by raising in the community a speculating mania.

What is to check this rise in prices and spirit of speculation? — I will now examine into the manner in which this rise in prices is ultimately to be checked, and the spirit for speculation to be cured. And here let me observe, that as there is a certain point of depression below which prices will not go, in consequence of the *influx* of precious metals which this lowness of prices will certainly produce, so likewise there is a certain point in the elevation of prices beyond which they cannot well go, because of the *efflux* of the precious metals. It is this efflux which finally checks the speculating mania. I will explain: a rise in prices, when very great, makes our country a good market to sell *in*, but a very bad one to sell *from*; hence our imports will greatly overbalance our exports, and a money balance will be created *against* the nation, which must be paid in money. This produces the exportation of money until the redundancy is sent off; then prices fall, and ruin overtakes the most adventurous in the game of speculation—they involve others, and prices once more sink, from loss of confidence and credit, and stagnation in circulation, below their average level, to be brought up again by the operation of causes already pointed out. Whenever the pendulum of price, (if I may use the expression,) has, either by the operation of the natural course of events, or by the unwise and unskilful tampering of government, been thrown far into one extreme of the arc, it will, in its effort to regain its natural position, go almost so far into the opposite extreme; and the vibrations will frequently last through a long period of time.

Do these Fluctuations depend entirely upon the Banks?—Some suppose these fluctuations depend *entirely* upon the operation of the banking system. This, however, is not the fact. Banks may do a great deal, but are by no means omnipotent in the re-

gulation of a currency. For example; when loss of confidence, stagnation of circulation, and fall of prices, derange the whole credit system, banks are affected like individuals; they are obliged to curtail their operations and check the farther emission of paper, lest a run upon them may break them. They may not under these circumstances have the ability to relieve the distress, however strong the inclination; the relief must come through the wasting process of *buying* metals from abroad. Again, when prices begin to mount upwards, banks, by seizing upon the favorable moment, may enlarge their issues, and thus swell still farther the already bloated state of the currency. But they cannot prevent, if they be specie-paying banks, the correction of the evil exportation of the metals; for so soon as these are redundant, they will be gathered up for a foreign market; a necessary run will then take place on the banks for the purpose of making the collection, and these banks must either suspend specie payment, curtail their issues, or break. On the first supposition, the evil would have to correct itself by a rise in exchange against us with foreign countries, to the amount of the depreciation caused in the currency by suspension of specie payment. In the second case, prices would be lowered by contraction of the currency from curtailment. In the third, by contraction from the withdrawal of all paper which had emanated from the broken banks, and a loss of confidence in the whole banking system, which would, by the runs made upon them, force all to curtail or break. And thus may we always confidently look forward sooner or later, from causes whose operation I have pointed out, for either a rise in prices when they are very low, or fall when they rise very high. Whenever prices are disturbed, it is a long time before the equilibrium is again restored.

Effect of Foreign Demand for some of our Agricultural Products on Present Prices.—So far I have been arguing as if the present state of things were the result solely of that re-action which must sooner or later take place after great depression and stagnation of trade. But the rise in prices may be rapidly accelerated by an extraordinary foreign demand for some of our great staples. Most undoubtedly the rise in the *price of cotton* has at this moment very great agency in the high prices and rage for speculation, manifesting themselves every where. The price of cotton in this country is regulated by the prices abroad, because the foreign market taking up about four-fifths of the whole product of the United States, it is evident that the value of the article must be determined by the foreign, and not by the home demand. What is the cause of the immense rise which has taken place in the price of cotton within a few months I am unable to say. I am not at this moment in a condition to get at the statistical information required for the investigation of this subject, and my mind not being particularly directed to it, until within a day or two past, I have not noticed from time to time in the papers such articles as might perhaps have given me a clue to the explanation of this interesting phenomenon. Whatever may be the cause, however, whether a general deficit in the cotton crops over the world, or in the United States particularly; or to the rapidly increasing demand for cotton fabrics all over the world; or to a spirit of speculation in England; or to the gradual reduction of the tariff; or to all these causes combined; certain it is, that the price of this most important agricultural staple is now at a height which well indemnifies the planter for his labor, and will, if it could continue, diffuse wealth and prosperity over the whole of our southern country.

Let us now examine into the influence exerted by this rapid rise in the price of cotton: and in the first place it is manifest, that the rise in the price of cotton must have had a most important influence on the foreign exchanges. This article alone constituting a very large portion of the whole of our exports, say two-thirds, a rise in its price has therefore tended to swell the value of our exports, and of course to make money flow more rapidly into the country, through the agency of a favorable balance of trade. From this cause, then, the late money pressure may have lasted a shorter time than it would under other circumstances.

Influence of the Price of Cotton on the Value of Slaves.—Again: the rise in the price of cotton has most undoubtedly given an impulse to the price of slaves. Cotton is the great agricultural staple throughout almost the whole of our southern slave-holding states, and consequently the marketable value of slaves will ever be determined by the value of the principal product of their labor. In Virginia and Maryland the price of slaves will always depend upon the external demand, and not on their intrinsic value in those two states.

If the price depended on the real demand arising among themselves, I doubt whether those states could afford to raise them even, so little would be their marketable value.

But there is another cause which I believe at *this moment* is operating in raising the price of slaves, and will exert a still more powerful influence in future. I mean the late *emancipation of the slaves in the Brit-*

ish West Indies. That act is certainly indefensible upon every ground of expediency, morality, and religion, but its impolicy appears most glaring when considered in a politico-economical light. Now, whatever may be said about the relative efficacy and value of free and slave labor, there is no question but that free labor, produced by sudden emancipation of slaves, is the most worthless and inefficient labor in the world. Let us take upon this subject the testimony of one who has favored emancipation in the West Indies, and who has already reaped some of the fruits of his folly. Lord Brougham, in his *Colonial Policy*, says, "The free negroes in the West Indies are, (with very few exceptions, chiefly in the Spanish and Portuguese settlements,) equally averse to all sorts of labor which do not contribute to the supply of their immediate and most urgent wants. Improvident and careless of the future, they are not actuated by that principle which inclines more civilized men to equalize their exertions at all times, and to work after the necessaries of the day have been procured, in order to make up for the possible deficiencies of the morrow. Nor has their intercourse with the whites taught them to consider any gratification as worth obtaining, which cannot be procured by slight exertion of desultory and capricious industry." The report of the committee of the Privy Council of Great Britain in 1788, of Mr. Braithwaite, the Agent for Barbadoes, and of M. Malouet, who bore a special commission to examine the habits and character of the Maroons in Dutch Guiana, all agree in asserting that free negroes are idle and worthless, and will never provide for the morrow with the foresight of civilized beings. The latter, M. Malouet, says: "Le repos et l'oisivete sont devenus dans leur etat social leur unique passion." Does not our own experience in this country prove the truth of his assertion? Do we not find the free negro the pest of the society wherever he is seen? He is the same idle, worthless creature in the north as in the south and west of our country. Have not the colonies at Sierra Leone and Liberia most conclusively proven the same fact? Does not the example of St. Domingo, which is now but a wreck of its former self, speak volumes on the same subject? Well, then, with all these facts and evidences before them, what could British statesmen have foreseen from the emancipation of slaves in the West Indies, but idleness and worthliness of the whole population? and is not this actually the result? Do not all the statements agree in asserting, that the system of apprenticeship has failed to realize the anticipated advantages? and the state of things will be still more deplorable if ever the negro shall obtain his perfect liberty. Now, what will be the consequence of all this? Why, that the British West Indies will soon cease to produce sugar for exportation, and will therefore throw the monopoly of its production into the hands of the slave-holding islands, and of Louisiana and the Floridas in our own country; and this will contribute at once to a rapid rise in slave property.

When St. Domingo was first liberated, the imaginations of mere speculative statesmen led them to behold a belt of black republics stretching through the West India Islands, diffusing their moral influence by commerce and social intercourse throughout the habitable globe. Now, what was the fact? Why, that St. Domingo was soon found to have such an idle, worthless population in her newly emancipated blacks, that her commerce was at once destroyed. She has entirely ceased to export sugar, although formerly the most productive sugar-growing island in the world. Under these circumstances, to talk of moral influence is perfectly absurd. Those black islanders have been, by the effects of their own laziness and vices, as effectually cut off from the rest of the world as if St. Domingo had been enclosed by Bishop Berkeley's forty-foot wall of brass. The London Quarterly Review, in one of its most powerful articles, asserts that nothing but the condition of St. Domingo would have enabled the British West Indies to have borne the oppression of the mother country as long as they did; that St. Domingo being thrown out of the competition in the production of sugar, gave a sort of monopoly to the British islands which enabled them to bear the oppressive regulating legislation of the Parliament. Provided we are let alone by the busy meddling philanthropists, who can attend to every body's business but their own, every negro that gets his liberty in the West Indies, or in South America, will contribute to a rise, upon precisely the same principles, in slave property in our country. The liberation of the slaves in the British West India islands is already producing that effect. If the French, Spaniards, Portuguese, Danes, &c. shall be unwise enough to follow this lead, the southern states of our Union will most assuredly reap the benefit; and if Brazil, too, should follow the example, the effect would be almost complete. It would give us a monopoly in both sugar and cotton. Sugar is not made by free labor any where in the world. Even in China, all the sugar and cotton districts are cultivated by slave labor, which in my opinion has set to rest forever, in warm countries, the question about the relative

advantages of free and slave labor. The cultivation of sugar requires a great deal of hard labor, which can be expected of the slave alone. In warm countries the principle of idleness triumphs over that of accumulation, and hence slave labor is universally the most efficient in warm and tropical latitudes. If all the slaves in the West Indies shall ever be liberated, Louisiana will become an *Eldorado*.

Effect of the Rise of the Price of Cotton and Slaves, on Corn, Wheat, Tobacco, &c.—The rise in the price of cotton and of slaves is of itself calculated to give an impulse, not only to all the agricultural products of the south, but of the north and west likewise, particularly of the west. Corn, which is the great staple of the middle states, is soon raised in value by high prices for cotton; because all the southern country, which is better adopted to the raising of corn than the middle states, raise cotton exclusively, and thus become purchasers of corn. The cultivation of cotton likewise gradually extends itself even into the middle states, and thus diminishes the quantity of corn raised still farther. In addition to these circumstances, there has been a deficient corn crop for the last two years, in consequence of distressing droughts in the latter part of the season, and too much rain in the commencement. Now, we must recollect that in any necessary of life, like corn, whose price is dependent on the home demand, if a deficit occur, the price will rise generally more than in proportion to the deficit.

The high price of cotton and corn will quickly communicate itself to horses, mules, hogs, cattle, &c., which constitute the great staples of the west; for with corn and cotton high, the middle and southern States will cease in a measure to rear those animals, and consequently will become purchasers. Wheat and tobacco, depending mostly on the foreign market, will not be so much affected. But as ours is the principal tobacco growing country for all Europe, and as an extension of the cultivation of corn and cotton has a tendency to diminish that of tobacco, it is evident that tobacco would be more influenced than wheat by a rise in the price of cotton and corn. Accordingly we find that tobacco is now selling very high. The high price of cotton is likewise calculated to make the south a better market for all the products of the north, and to give increased activity to the commercial interest, in which the north possesses the deepest stake. Mr. Lee, the author of the celebrated Boston Report on the Tariff, and one of the best statists which this country can boast of, estimated the advantage flowing to the north from the transportation of the cotton of the south, as equal to $5,000,000 on cotton, amounting in value to $25,000,000.

Summary of the Causes of the Present Prices.—Thus have I rapidly sketched out the causes which have been operating in producing the present prices. In the first place, the late removal of the deposites, and the consequent caution and curtailment of business on the part of the Bank of the United States, together with the unfriendly relations existing between that bank and the state banks, which imposed the necessity of a similar curtailment on the latter, gave a shock to public and private credit, which plunged the country into the greatest distress, and rendered the circulating medium scarce every where, by both diminution of quantity and of the rapidity of circulation. This at once brought down prices to a minimum. The importation of the precious metals from abroad was the immediate consequence of lowness of prices, and tended to relieve the pressure by increasing the currency. By and by, the banks that rode safely through the storm, began, when things settled down, to enlarge their business, confidence and credit were restored, and a redundant circulating medium is the consequence. This of itself is capable of producing high prices, independent of other causes; but in the present instance, it has been aided by the great foreign demand for cotton, which, together with the emancipation of slaves in the British West Indies, has made slaves rise in value throughout our slaveholding country. It has indirectly contributed to the high prices of corn, tobacco, and the staples of the west, and will no doubt, if it continues, diffuse prosperity over all the northern states, in the way I have already explained.

Prospects.—In the mean time, let me ask what are our prospects? I answer, that this rise in prices has already excited a rage for speculation, which will, in all probability, carry up prices still higher. A fever for speculation, when once excited in the body politic, always produces, both economically and morally, the most disastrous consequences. It destroys that regular persevering industry by which alone a nation can be enriched. It attracts the capital and resources of the country towards chimerical projects and airy bubbles. During the prevalence of the South Sea scheme in England, hundreds of projects were set on foot, and the sums proposed to be raised by these expedients amounted to more than $300,000,000, which exceeded the value of all the lands in England. On these occasions, so intoxicated do the people become with a spirit of adventure, that they fall victims to the grossest delusion. Only call it a joint

stock company, and thousands of dollars instantly flow into the scheme. All are anxious to enrich themselves by a single stroke of good fortune. The hard-working, plodding man, is looked upon with contempt. Habits of the most luxurious and vicious character are speedily introduced. There is nothing more true than the old adage, "*easy come—easy go.*" A man who makes a fortune at a stroke, is almost sure to spend it extravagantly. He must live high, and give costly entertainments, to purchase the attention and consideration of the new circle into which his wealth has just introduced him. The great merchants, lawyers, physicians, &c. follow the example which is set by the speculators—a reckless, profligate, gambling spirit, is spread through the country—one half the nation is trying to grow wealthy by the ruin of the other half. Every kind of deception, falsehood, and trickery, are resorted to for the purpose of influencing the markets. "During the infatuation produced by this infamous scheme, (South Sea,)" says the historian, "luxury, vice, and profligacy, increased to a shocking degree of extravagance. The adventurers, intoxicated by their imaginary wealth, pampered themselves with the rarest dainties, and the most expensive wines that could be imported; they purchased the most sumptuous furniture, equipage, and apparel, though without taste or discernment; they indulged their criminal passions to the most scandalous excess; their discourse was the language of pride, insolence, and the most ridiculous ostentation; they effected to scoff at religion and morality, and even to set heaven at defiance." A bill was actually brought into the British Parliament for the suppression of blasphemy and profaneness, to so fearful a degree had the spirit of speculation and gambling effected the morals of the people.

The disastrous influence of this rage for speculation in our own country, during 1817, 1818, and part of 1819, was almost as great as that produced in England by the celebrated South Sea bubble, or in France by the Mississippi scheme.

With regard to Virginia, I do not think the mania will be so apt to reach her in its most aggravated form: the high price of negroes and cotton, now producing a fearful emigration to South West, where golden harvests will be realized, if present prices can only be kept up, the spirit for speculation will in a great measure direct itself towards south-western lands. Hence, although corn, wheat, and tobacco, may rise, this exhausting drain of our labor and capital to the south-west will keep land in this state from rising *pari passu*. Our labor and capital both are swept from our soil as fast as accumulated. At this moment in Virginia, there is a mighty struggle going on between the elastic principle of the black population on the one hand, and the drain to the south-west on the other. And if the high price of slaves shall be kept up for a few more years, I doubt whether all the procreative energies of the race can compensate for the emigration; and in that event we shall be obliged to fill up with Irishmen and northern laborers, or leave the soil of the state comparatively stript of labor. In the mean time, however, let us preserve our sobriety, our industry, and our morality, enjoying the present advantages of high prices, without rushing into schemes and adventures of a wild and reckless character, under the vain belief that these times are to last forever. Sooner or later, if prices rise above the natural level, they must come down by a process which I have already pointed out. If cotton shall fall speedily, or if a superabundant corn crop shall be made this year, these extravagant prices would be checked at once. And we must recollect, too, that the Bank of the United States is quickly to wind up, and if its curtailment shall be very rapid, it may force the whole banking system of the country to contract its accommodation, and thus, perhaps, to give a shock once more to public confidence. At all events, let us remember the moral of the famous epitaph—"I was well—I wished to be better—and here I am."

May 21, 1835.

[From the American Railroad Journal.]

FOOT RAILROADS.

It is proposed to show in this article, that railroads for short distances may be used to advantage by men to transport themselves and moderate loads by their own strength.

1. In showing this, I may first state the force of traction required on railroads. The force of traction is measured by a weight suspended to a cord passing over a pulley. The traction, or tractive power of a horse, is said to be 125 pounds, because a horse at his ordinary labor draws with a force sufficient to raise up 125 pounds by a cord over a pulley. The tractive power necessary to move waggons on common roads, and cars on railroads, has been very accurately ascertained. If a waggon with its load weighs 2400 pounds, then, if a weight of 200 pounds is suspended to a cord passing over a pulley, which cord draws the waggon, this weight would move the waggon forward on a good level turnpike road. But a car on a level railroad, weighing with its load 2400 pounds, would be moved forward by a weight of only ten pounds, suspended to a cord running over a pulley. If then a man

could draw up a weight of ten pounds, he could, with the same rapidity that it ascends, move forward, on a level railroad, a car and its load weighing together 2400 pounds. If he could draw ten pounds up ten feet in a second, he could move the car and its load ten feet in a second; and if he could do this for an hour in succession, he could then move forward the car and its load 3600 feet in the hour. But if the railroad rises but 22 feet in a mile, the traction of 10 pounds will not move 2400 pounds up this ascent; but the traction of 10 pounds must be added, or the traction of 20 pounds will be needed; and if the ascent is 44 feet in a mile, another additional traction of 10 lbs. must be made, or there must be a traction of 30 pounds. The traction of 10 pounds, at 10 feet in a second, might be made to operate on a car 20 feet in a second; but the traction of ten pounds would not move a car weighing 2400 pounds 20 feet in a second, for it would propel only half the weight, or 1200; and if the traction of 10 pounds, at 10 feet in a second, were made to move a car 40 feet in a second, it would propel a car at this rate weighing only 600 pounds. With the same power with which a weight of 2400 pounds is moved forward on a level railroad 3600 feet, a weight of 600 pounds might be propelled four times that distance, or 14,400 feet.

2. What now is the power ordinarily exerted by a laboring man? Different estimates are made of this power. By Dr. Farey, a recent writer on the steam engine, the power of man is assumed to be equal to the raising of 60 cubic feet of water, which is equal to 3750 lbs. avoirdupois, through the space or height of one foot in a minute. A stout laborer, says Dr. Farey, will continue to work at this rate during eight hours per day. The relative values of the labor of a man and a horse, as to physical strength exerted, are variously stated. Some estimate them as 1 to 5, some as 1 to 6, and some as 1 to 7. The efforts of men differ with the manner in which these efforts are employed. It has been estimated by Mr. Buchanan, that the same quantity of human labor employed in working a pump, turning a crank, ringing a bell, and rowing a boat, are as the numbers 100, 167, 227, 248. The strength of man could be applied in the most economical way on a railroad, and so as to act with even more efficiency than in rowing a boat. He might sit in a reclining posture like a man pulling an oar, with his feet pushing against the flat boards of a small wheel, and by his hands drawing upon the slats of a drum wheel, instead of drawing upon an oar, while the wheel on which his feet operate, and that on which his hands operate, act on the same working point. This machinery might occupy but about the space filled by two chairs, or very little more than is required by one man to sit at his ease.

Attempts have been made to construct carriages by which a man might propel himself on common roads; but a knowledge of the power of traction necessary on common roads, would show that this is wholly impracticable. If a man's weight is 175 pounds, it would require an additional tractive power of 14½ to move himself on a common road, while this additional power would of itself alone move forward on a level railroad 3480 pounds; but for a man to move himself forward on a level railroad would require an additional traction of only two thirds of a pound, if his weight is 175 pounds.

If a laboring man ordinarily exerts strength sufficient to raise 3750 pounds 10 feet high in a minute, then he could propel 3750 pounds 240 feet in a minute, or half a mile in 12 minutes; or he could propel 937 pounds one mile in six minutes, or ten miles in an hour, and do this for eight hours in a day.

3. The attention may now be directed to the various occasions persons have to go, or to carry goods for short distances. Among the new and striking circumstances that in the city arrest the visitor from the country, is the throng of carts, and carriages, and horses, crowding the streets, and stunning his ears. This fact shows that there is a vast amount of conveyance of persons and loads from one part of a city to another. While such an amount of transportation is demanded by the necessities and convenience of the people of a city, it is manifest that railroads along some principal streets, reducing the freight of goods and persons to one tenth, or one third of its present cost, would be an immense gain to the community. The result would be that much mechanic business needed in a city would be done at a distance, where there was more room, and where on many accounts it could be done to more advantage. By the railroad the mechanic would be as near his customers four miles off, as he is now one third of a mile. From a centre of business a man might transport himself with great ease several miles for his food and lodging, since, as easily as he would walk up stairs, or up a hill, 22 feet, with two pounds weight in his hand, he could move forward a mile on a level railroad, transporting himself, whatever is his weight, and moving his car also weighing 480 lbs. Or, supposing that it is about as fatiguing to a man to walk at the rate of three miles an hour, as to work for that time with the strength of a laboring man, then, as easily

as he could walk one mile to his lodgings or home, he could propel himself and car, weighing together 625 pounds, 4¾ miles on a level railroad, and in the same time that he could walk a third of a mile. In the country an immense advantage would accrue from light and cheap railroads to centres of business, to get to stores, to physicians, to schools, to public lectures, and meetings, and to religious assemblies.

The influence of such means of communication on intellectual, moral, and religious improvement, I would set above all other advantages. The greatest mental and moral debasement is found in remote country neighborhoods, and in dark city lanes, and their deep cellars.

4. The position of places of business is ordinarily such that they can be accommodated to a great extent by level railroads. Cities are commonly built on navigable waters; and the business in them is done along a water line, and here are ranged the workshops and stores. Railroads from the country will naturally terminate on this level, for they must be kept on low ground, and in the vallies of streams, which keep the lowest and most level courses. The railroads from Providence and Worcester terminate in Boston at what was once the neck, from whence very level rail paths might extend to the principal wharves, and indeed around the whole city. Rail tracks, extending from the termination of these railroads over the city, would greatly promote the success of the railroads, for, on a level track, a horse might draw several cars and loads, weighing together 12 tons. A car might receive the passengers directly from the steamboat, or travellers might enter one at their hotel, and without being delayed by the long process of getting seated at the head of the railroad, the cars, all loaded, might meet almost at the minute from different quarters, and pursue their course without hindrance.

Slight and cheap lines of railroad for the application of human power, intersecting the city and country, will accommodate especially the great body of the middling and poor classes, and may thus do as much good as the grand and heavy railroads, on which the ponderous cars of three and four tons weight are rolling; and they may add vastly to the business of these main channels of communication. If there are to be conveyed loads of 50, 100, 200, or 500 pounds, porters could convey them as easily on their light cars on rail tracks, as they could walk on a common road without any burden. To draw a load of 480 lbs. a man has to exert only the power that would raise two pounds over a pulley; and to move himself also on his load, he would have to exert only the additional tractive power of one third of a pound. The effect of cheap rail tracks would be as though a railroad terminated at each man's door.

By these facilities of communication, both the country and the town would be benefitted. Labor is nearly double in the city what it is in the country; and this is a loss to the laborer and the employer. It is a loss to the employer, because the labor he gets costs him so much; and it is a loss to the laborer, because his expenses are great and his accommodations poor. It is a loss also to the laborer in the country, because he cannot get the products of his labor to market without losing a great part of their value. The expense of transportation is a dead loss to the public; and by how much this expense is reduced, by so much is the whole public benefitted.

PUBLICOLA.

[From the American Railroad Journal.]

On the Location of Railroad Curvatures; being an Investigation of all the Principal Formulas which are required for Field Operations, in laying Curves and Tangent Lines, to pass through Given Points.

By J. S. VAN DE GRAAFF.

(Continued from vol. vi., page 36.)

24. When the given curve ADF, (see fig. art. 23,) has been actually traced in the field, the co-ordinates x, y, have to be computed by means of (VII.) in order to obtain the distance FR, as proposed in the last article. In such a case, *if the two moduli of curvatures* T *and* T′ *be equal to each other*, the distance FR and the angle P will be more conveniently had by means of a direct formula in terms of n, m, T, and $\propto$, without first computing the values of the co-ordinates x, y, and x', y'. For when (XXIII.) is developed, agreeably to the common principles of algebra, the result is, $w = (x^2 + y^2 + x'^2 + y'^2 - 2xx' - 2yy' - 2\propto . x' - x + \propto^2)^{\frac{1}{2}}$; and by substituting in this equation for x, y, and x', y', their values obtained from (VII.), upon the supposition that T = T′; suppressing the quantities which cancel each other, and reducing the result, agreeably to the principles of analytical trigonometry; the following formula will be then obtained:

$$w = \left\{ \frac{1-\text{Cos.}(2n\text{T}-2m\text{T})}{1-\text{Cos.}2\text{T}} - \propto \times \frac{\text{Sin.}2m\text{T}-\text{Sin.}2n\text{T}}{\text{Sin.T}} + \propto^2 \right\}^{\frac{1}{2}} \quad \text{(XXV.)}^*$$

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* When $2m\text{T} > 2n\text{T}$, then $2n\text{T}-2m\text{T}$ becomes a *negative* quantity. It must, however, be remembered that *negative arcs*, which are less than 90°, have *positive cosines*. The quantity Sin.$2m$T—Sin.$2n$T, will be *negative* when the latter *sine* is the greatest.

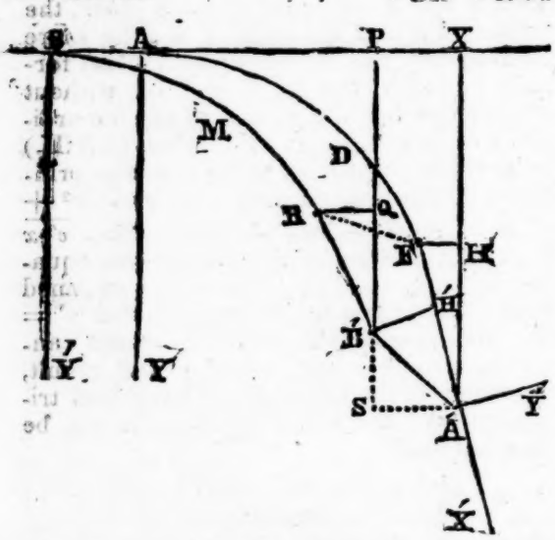
The *sign* of the quantity α, is here supposed to be

Thus, an expression for the value of w has been obtained, which will be quite convenient for use in the field, with the table of *natural* sines and cosines, and the table of the squares and square roots of numbers, subjoined to this volume. But the values of the co-ordinates x, y, and x', y', not being here computed, a new formula will be required for determining the angle P. For this purpose it will be only necessary to substitute in Cos. $P = \frac{x' - x - \propto}{w}$, the valves of x' and x, as obtained from (VII.) The following expression will be then obtained:

$$\text{Cos. P.} = \frac{\frac{\text{Sin.}2m\text{T} - \text{Sin.}2n\text{T}}{2\text{Sin.T}} - \propto}{w} \quad \text{(XXVI.)}$$

A formula expressing the value of Cos. P, has been here selected in preference to one for the value of Sin. P, for the obvious reason that the principal term in the numerator of (XXVI.) is had by simply dividing by 2, one of the quantities in (XXV.), whose value will always be previously known from the computation of w. But with regard to the *sign* of sine P, it may be observed that, in the case here under consideration, Sin. P will always be *positive* when $n-m$ is *positive*; and vice versa.

If in (XXV.), it be supposed that $n = m$, the result is, $w = \propto$. That is, *the distance between the two curves, in a direction parallel to the common tangent at the origins, is always the same constant quantity* $= \propto$. See art. 11.



25. Suppose ADF to represent a given curve, and BMR another proposed curve laid upon the same tangent line AX, and let $\propto$ denote the given distance AB, between their origins. Take T and T', to represent the given moduli of curvatures; and let each curve pass into a tangent, FA', and RB', at the extremity of the nth and mth chain respectively. Let the number of chains contained in each tangent be denoted by v and v' respectively. It is then required to determine the distance A' B', between the extremities of those two tangents. And taking A' X', A' Y', for a system of rectangular co-ordinate axes, coinciding with the given origin A', and tangent line A' F, it is proposed to investigate expressions for the values of the co-ordinates A' H', H' B', of the point B'.

The first thing which will be required, in the present inquiry, is the value of each of the co-ordinates AX, XA', and BP, PB', of the two points A' and B', estimated from the primitive axes AX, AY, and BX, BY'. Let those co-ordinates be represented by X, Y, and X', Y', respectively. The following equations will then evidently exist, $\left\{\begin{matrix} X = x + FH \\ Y = y + A'H \end{matrix}\right.$; but by (IV.), $\angle HFA' = 2n\text{T}$, and therefore by the principles of trigonometry, $FH = v \cdot \text{Cos.}\, 2n\text{T}$, $A'H = v \cdot \text{Sin.}2n\text{T}$. The following formulas will therefore be the result:

$$\begin{matrix} X = x + v \cdot \text{Cos.}2n\text{T} \\ Y = y + v \cdot \text{Sin.}2n\text{T}. \end{matrix} \quad \text{(XXVII.)}$$

And in like manner the following similar equations may be obtained:

$$\begin{matrix} X' = x' + v' \cdot \text{Cos.}2m\text{T}' \\ Y' = y' + v' \cdot \text{Sin.}2m\text{T}'. \end{matrix} \quad \text{(XXVIII.)}$$

Now, taking W to denote the required distance A'B', its value will obviously be expressed in the following manner:

$$W = \left\{ \overline{X + \propto - Y'}|^2 + \overline{Y - Y'}|^2 \right\}^{\frac{1}{2}} \quad \text{(XXIX.)}$$

The theorems (XXVII.) will frequently find an application in the field, as a means of investigating particular cases which will occur where tangents are concerned; and in every case in which the line A' B' is required to be known, its value cannot be computed by any other method with more ease than by (XXIX.), a table of the squares and square roots of numbers being at hand.

It will sometimes happen that the point B' is required to be the origin of a new curve, whose modulus of curvature must be found by means of data furnished from another curve *previously computed*, or actually traced, from the origin A', and axes A' X', and A' Y''; and in such a case, the co-ordinates A' H', H' B', furnish the most convenient data for computing the new curvature, which was fully explained in article 22.

Put, $\propto' = A'H'$, and $\beta' = H'B'$; and for the sake of convenient notation, take $k = X + \propto - X' = S\,A'$, and $h = Y - Y' =$

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subject to the same *conditions* as in (XXIII.), and (XXIV.); and the same thing, in all cases, must be hereafter understood.

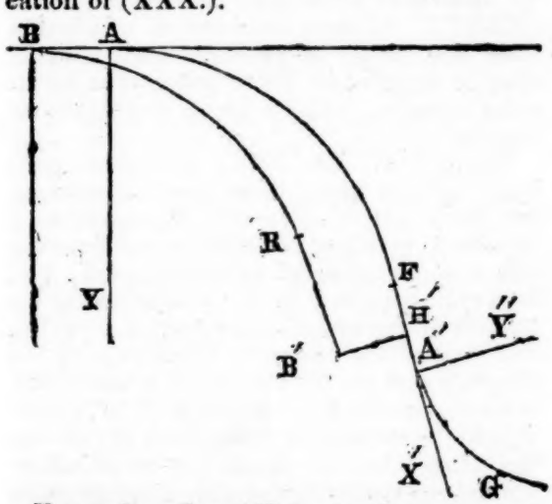
S B′. It is obvious that, $\angle$ S A′ H′ $= 2nT$, and $\angle$ S B′ H′ $= 180° - 2nT$; and therefore, agreeably to a well known theorem in plane trigonometry,* a diagonal from S to H will be expressed either by

$$\overline{k^2 + \alpha'^2 - 2k\alpha' \cdot \text{Cos. } 2nT}|^{\frac{1}{2}},$$

or by $\overline{h^2 + \beta'^2 + 2h\beta' \cdot \text{Cos. } 2nT}|^{\frac{1}{2}}$; these two quantities are therefore equal, and consequently recollecting that $\alpha'^2 + \beta'^2 = h^2 + k^2$, the result will be $\alpha'^2 - h^2 = k\alpha' \cdot \text{Cos. } 2nT + h \cdot (h^2 + k^2 - \alpha'^2)^{\frac{1}{2}} \cdot \text{Cos. } 2nT$; that is, $\overline{\alpha'^2 - h^2}|^2 + k^2\alpha'^2 \cdot \text{Cos.}^2 2nT - 2k\alpha' \cdot (\alpha'^2 - h^2) \cdot \text{Cos. } 2nT = h^2 \cdot (h^2 + k^2 - \alpha'^2) \cdot \text{Cos.}^2 2nT = h^2k^2 \cdot \text{Cos. } 2nT - h^2 \cdot (\alpha'^2 - h^2) \cdot \text{Cos.}^2 2nT$; or, $\overline{\alpha'^2 - h^2}|^2 - 2k\alpha' \cdot (\alpha'^2 - h^2) \cdot \text{Cos. } 2nT = -k^2 \cdot (\alpha'^2 - h^2) \cdot \text{Cos.}^2 2nT - h^2 \cdot (\alpha'^2 - h^2) \cdot \text{Cos.}^2 2nT$; that is, $\alpha'^2 - h^2 - 2k\alpha' \cdot \text{Cos. } 2nT = -(h^2 + k^2) \cdot \text{Cos.}^2 2nT$; and this equation is now easily reduced, by the method of quadratics, to the form, $\alpha' - k \cdot \text{Cos. } 2nT = h \cdot \text{Sin. } 2nT$. By pursuing the same method with regard to β', a similar result will be obtained; and thus the formulas which it was proposed to investigate are the following:

$$\alpha' = k \cdot \text{Cos. } 2nT + h \cdot \text{Sin. } 2nT$$
$$\beta' = k \cdot \text{Sin. } 2nT - h \cdot \text{Cos } 2nT. \qquad \text{(XXX.)}$$

It is easy to see that the expressions just obtained might have been deduced with more facility immediately from (XXI.); but a special investigation was considered preferable. The following case may be assumed, in order to show a practical application of (XXX.).



Example. Let AX be a given tangent line, and A the given origin of a curve. From the origin A, and parallel to the axes AX, AY, let a system of rectangular lines be traced to a certain designated point F, selected in such a manner as to give an *integer* number of chains in the curve AF, agreeably to the method explained in art. 17; and let the values of T, n, x, and y, as deduced therefrom, be, $T = 2° 3'$, $n = 18$ chains, $x = 13{\cdot}40$ chains, and $y = 10{\cdot}08$ chains. From the point F suppose a tangent FA′ to be laid 9 chains, agreeably to the method explained in art. 16; and from the point A′, as a new origin, and parallel to the rectangular axes A′ X′, A′ Y″, let a second system of rectangular lines be traced, terminating in a certain designated point G, and let the resulting equations give $\left\{\begin{matrix} x = 10\cdot \\ y = 10\cdot \end{matrix}\right\}$ chains, agreeably to art. 16. Now, having computed the modulus of curvature of A′ G, and examined the direction at G, suppose it be found, in consequence of the particular situation of the ground from A′ to G, to be advisable to change the origin of the curve AF to a point B, 4 chains *back* upon the tangent line AX, and from thence to lay a curve BR, from the same modulus of curvature, for a distance of 15 chains to the point R; and then a tangent RB′ for a distance of 12 chains to the point B′. It is then proposed to know what modulus of curvature will trace a curve from the tangent line RB′, and from the origin B′, passing through the same designated point G.

In such a case as the present, the co-ordinates x', y', X′, Y′, and X, Y, of the points R, B′, and A′, respectively, will most generally have been already computed in making a proper selection of the points R and B′, before any calculation is wanted with regard to the modulus of curvature of the required curve from B′ to G. But to show an example in figures, of the manner of obtaining those co-ordinates, the given data at present are, $T = 2° 3'$, $n = 18$, $x = 13{\cdot}40$, $y = 10{\cdot}08$, $v = 9$, $T' = 2° 3'$, $m = 15$, and $v' = 12$. Hence, $2nT = 73° 48'$, $2mT' = 61° 30'$; and by (VII.), $x' = \frac{\text{Sin. } 61° 30'}{2\text{Sin. } 2° 3'} = \frac{\cdot 87882}{\cdot 07154} = 12{\cdot}28$, $y' = \frac{1 - \text{Cos. } 61° 30'}{2\text{Sin. } 2° 3'} = \frac{\cdot 52284}{\cdot 07154} = 7{\cdot}31$; and by (XXVII.), $X = 13{\cdot}40 + 9 \times \text{Cos. } 73° 48' = 13{\cdot}40 + 9 \times \cdot 279 = 13{\cdot}40 + 2{\cdot}51 = 15{\cdot}91$, $Y = 10{\cdot}08 + 9 \times \text{Sin. } 73° 48' = 10{\cdot}08 + 9 \times \cdot 960 = 10{\cdot}08 + 8{\cdot}64 = 18{\cdot}72$; and by (XXVIII.), $X' = 12{\cdot}28 + 12 \times \text{Cos. } 61° 30' = 12{\cdot}28 + 12 \times \cdot 477 = 12{\cdot}28 + 5{\cdot}73 = 18{\cdot}01$, $Y' = 7{\cdot}31 +$

* This theorem is sometimes wanted in the field, and it may therefore be convenient to have it expressed here, in the usual form. Take a, and b, to denote any two sides of a plane triangle, and let X represent the *contained* angle, and x the opposite side. Then

$$x^2 = a^2 + b^2 - 2ab \cdot \text{Cos. X}.$$

$12 \times$ Sin. $61° 30' = 7{\cdot}31 + 12 \times {\cdot}879 = 7{\cdot}31 + 10{\cdot}54 = 17{\cdot}85$. We now have $k = 15{\cdot}91 + 4{\cdot}00 - 18{\cdot}01 = 1{\cdot}90$, $h = 18{\cdot}72 - 17{\cdot}85 = 0{\cdot}87$; and by (XXX.), $\alpha' = 1{\cdot}9 \times {\cdot}279 + {\cdot}87 \times {\cdot}960 = {\cdot}53 + {\cdot}84 = 1{\cdot}37$, $\beta' = 1{\cdot}9 \times {\cdot}960 - {\cdot}87 \times {\cdot}279 = 1{\cdot}82 - {\cdot}24 = 1{\cdot}58$, which are therefore the values of the co-ordinates of the new origin B′; and thus the required modulus of curvature is readily found, by means of (XXII.), to be $= 1° 56'$.

It will sometimes be very convenient in the field, to determine by measurement the values of the co-ordinates, A′ H′, H′ B′, of the new origin B′, after the new line BRB′ has been traced up to the point B′.

26. Let the characters α, n, m, T, and T′, represent the same things as in the preceding article, and suppose the conditions with relation to the curves ADF, and BMR, to remain. Produce the two tangents FA′, and RB′, until they intersect each other; and take v, and v', to denote the number of chains in each respective tangent to their common point of intersection, and let z represent the angle of intersection. It is then proposed to investigate the general equations which subsist among those various quantities, in order that, when the circumstances in the field are such as to make any one of the quantities α, m, T′, v', or z, unknown, that quantity may then be eliminated, and its value obtained.

The first equation which will be required, in the investigation of any case where the *intersection* of two tangents is concerned, may be immediately deduced from (V.), and is expressed as follows:

$$2n\mathrm{T} - 2m\mathrm{T}' - z = 0. \quad \text{(XXXI.)}$$

And thus any one of the three quantities m, T′, or z, will be made known, when the *other two* are given, or assumed in such a manner as the situation of the ground may require. If, however, z be a quantity whose value is given, and fixed by particular circumstances in the field, then the value of T′ should generally be taken in such a manner as to give m an integer number, when eliminated from the equation $2n\mathrm{T} - 2m\mathrm{T}' - z = 0$.

The second subject of inquiry will now be an investigation of such equations as express the relations which exist between the quantities α, v, and v'. In the case here under consideration, it is evident from (XXIX.), that $\overline{\mathrm{X} + \alpha - \mathrm{X}'}|^2 + \overline{\mathrm{Y} - \mathrm{Y}'}|^2 = 0$; and therefore, agreeably to the principles of algebra, $\mathrm{X} + \alpha - \mathrm{X}' = 0$, and $\mathrm{Y} - \mathrm{Y}' = 0$; that is, $\alpha + x + v \cdot \mathrm{Cos.}\ 2n\mathrm{T} - x' - v' \cdot \mathrm{Cos.}\ 2m\mathrm{T}' = 0$, and, $y + v \cdot \mathrm{Sin.}\ 2n\mathrm{T} - y' - v' \cdot \mathrm{Sin.}\ 2m\mathrm{T}' = 0$. From the last of these two equations, let the value of v' be obtained, and substituted in the first. The result is, $\alpha \cdot \mathrm{Sin.}\ 2m\mathrm{T}' - v \cdot \mathrm{Sin.}\ z + \overline{x - x'} \cdot \mathrm{Sin.}\ 2m\mathrm{T}' - \overline{y - y'} \cdot \mathrm{Cos.}\ 2m\mathrm{T} = 0$; and in like manner, $\alpha \cdot \mathrm{Sin.}\ 2n\mathrm{T} - v' \cdot \mathrm{Sin.}\ z + \overline{x - x'} \cdot \mathrm{Sin.}\ 2n\mathrm{T} - \overline{y - y'} \cdot \mathrm{Cos.}\ 2n\mathrm{T} = 0$. But by (VII.), $x - x' = \frac{\mathrm{Sin.}\ 2n\mathrm{T}}{2\ \mathrm{Sin.}\ \mathrm{T}} - \frac{\mathrm{Sin.}\ 2m\mathrm{T}'}{2\ \mathrm{Sin.}\ \mathrm{T}'}$, and, $y - y' = \frac{1 - \mathrm{Cos.}\ 2n\mathrm{T}}{2\ \mathrm{Sin.}\ \mathrm{T}} - \frac{1 - \mathrm{Cos.}\ 2m\mathrm{T}'}{2\ \mathrm{Sin.}\ \mathrm{T}'}$; which values being substituted in the last equations, and the obvious reductions made, the two following equations will result:

$$\alpha \cdot \mathrm{Sin.}\ 2m\mathrm{T}' - v \cdot \mathrm{Sin.}\ z + \frac{\mathrm{Cos.}\ z - \mathrm{Cos.}\ 2m\mathrm{T}'}{2\ \mathrm{Sin.}\ \mathrm{T}} - \frac{1 - \mathrm{Cos.}\ 2m\mathrm{T}'}{2\ \mathrm{Sin.}\ \mathrm{T}'} = 0;$$

$$\alpha \cdot \mathrm{Sin.}\ 2n\mathrm{T} - v' \cdot \mathrm{Sin.}\ z - \frac{\mathrm{Cos.}\ z - \mathrm{Cos.}\ 2n\mathrm{T}}{2\ \mathrm{Sin.}\ \mathrm{T}'} + \frac{1 - \mathrm{Cos.}\ 2n\mathrm{T}}{2\ \mathrm{Sin.}\ \mathrm{T}} = 0.$$

(XXXII.)

Such is the second system of equations which will be required in the field.* The following cases may be given to illustrate their application:

Case I. When v, z, and T′, are *given*, to find α.

Here, by an evident transposition of the first of the equations (XXXII.), the following formula is obtained:

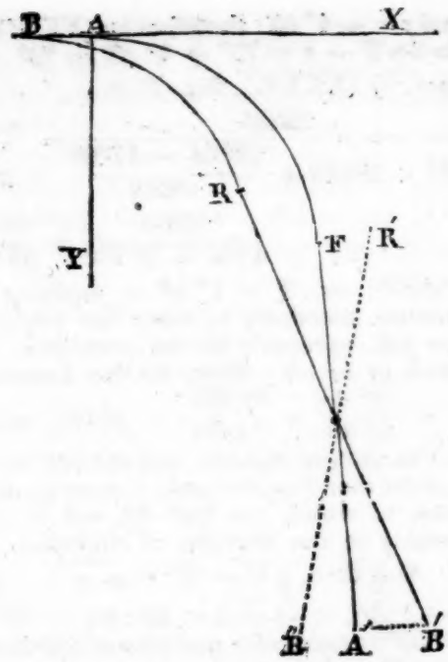
$$\alpha = \frac{v \cdot \mathrm{Sin.}\ z + \frac{1 - \mathrm{Cos.}\ 2m\mathrm{T}'}{2\ \mathrm{Sin.}\ \mathrm{T}'} - \frac{\mathrm{Cos.}\ z - \mathrm{Cos.}\ 2m\mathrm{T}'}{2\ \mathrm{Sin.}\ \mathrm{T}}}{\mathrm{Sin.}\ 2m\mathrm{T}'}.$$

(XXXIII.)

And the quantity α thus becomes known; for the value of m may be obtained from (XXXI.). In every instance in which this case will occur in practice, such a value may be selected for T′, as will give m an integer number, without doing any injury to the line.

Example 1. Let AX be a given tangent line, and A a given point therein, selected for the origin of a curve. By means of a system of rectangular lines, traced from the origin A, and parallel to the axes AX, AY, let a certain point F be designated, as the situation of the ground may seem to require, and in such manner as to coincide with the extremity of the 25th chain of a curve AF, whose modulus of curvature is $1° 30'$, agreeably to the method explained, art. 17. From the point F, let a tangent FA′ be traced 60 chains, agreeably to the principles given in art. 16; and from the point A′ trace the rec-

* In order to avoid misapprehension and error, particular attention must be paid to the *sign* of the angle z, which, in all cases where $2m\mathrm{T}'$ exceeds $2n\mathrm{T}$, is to be made negative; or, the angle z is to be accounted negative, when the tangent v' is *more* inclined than v, to the common tangent at the origins.



tangular ordinate A′ B′, 2·5 chains, to a point B′, selected in consequence of the particular situation of the ground. Now, suppose S to be a point in the tangent line FA′, 30 chains from F, through which the peculiar situation of the ground renders it desirable that a new tangent RSB′ should be laid. It is then proposed to determine the position of such a point B, in the primitive tangent AX, as will be the proper origin of a new curve BR, passing into the proposed tangent line RSB′.

It is here supposed, as the figure indicates, that the line RSB′ has an inclination, less than the line FSA′ to the common tangent AX; and consequently, in this instance, the angle z will be *positive*, and expressed by the angle A′ S B′. By plane trigonometry, $\text{Tan.}\, z = \frac{\text{A}'\,\text{B}'}{\text{A}'\,\text{S}} = \frac{2{\cdot}5}{30} = {\cdot}08333$; or, $z = 4° 46'$. Hence, by (XXXI.), $2m\text{T}' = 2n\text{T} - z = 75° - 4° 46' = 70° 14'$; or, $m\text{T}' = 35° 7'$. Now, the values of the quantities m and T′ may be taken in any arbitrary manner, provided the equation $m\text{T}' = 35° 7'$ be satisfied. The peculiar situation of the ground, between the points A and F, must therefore *decide* the values of m and T′. The object should be to make the new curve BR as *long* as the *limits of expense* will allow; for in the same proportion as that curve is made longer, it will also be made of less abrupt curvature; but it will then diverge farther to the right of the first curve AF. Let it be supposed that the new curve BR may have a length of 20 chains; then, $\text{T}' = \frac{35° 7'}{20'} = 1° 45\frac{1}{3}'$, which will therefore be the modulus of curvature of the new curve BR. And now, to find the necessary position of the origin B, we have, by (XXXIII.),

$$\propto = \frac{30 \times \text{Sin.}\, 4° 46' + \frac{1 - \text{Cos.}\, 70° 14'}{2\,\text{Sin.}\, 1° 45\frac{1}{3}'} - \frac{\text{Cos.}\, 4° 40' - \text{Cos.}\, 70° 14'}{2\,\text{Sin.}\, 1° 30'}}{\text{Sin.}\, 70° 14'}$$

That is, $\propto =$

$$\frac{30 \times {\cdot}08310 + \frac{{\cdot}66181}{{\cdot}06128} - \frac{{\cdot}99654 - {\cdot}33819}{{\cdot}05236}}{{\cdot}94108} =$$

$$\frac{2{\cdot}493 + 10{\cdot}800 - 12{\cdot}573}{{\cdot}941} + \frac{{\cdot}720}{{\cdot}941} = {\cdot}765.$$

Hence, measure the distance AB = ·765 of a chain, *back* upon the tangent line AX, and the required *origin* of the new curve BR will be obtained.

Example 2. Suppose the same data to remain as in the preceding instance, wit the exception only that the position of the required new tangent R′ S B″, is reversed; that is, let the line R′ S B″ have an inclination exceeding that of the line FSA′, to the common tangent AX.

Here the angle z becomes *negative*, and therefore, by (XXXI.), $2m\text{T}' = 2n\text{T} - z = 75° + 4° 46' = 79° 46'$; or, $m\text{T}' = 39° 53'$. And hence, if it be supposed that the ground between the points A and F be such as to admit a new curve 40 chains in length, then $\text{T}' = \frac{39° 53'}{40} = 0° 59\frac{4}{5}' =$ modulus of curvature of the new curve. Now, recollecting that Sin. z becomes *negative*, and Cos. z remains *positive*, we have

$$\propto = \frac{-30 \times \text{Sin.}\, 4° 46' + \frac{1 - \text{Cos.}\, 79° 46'}{2\,\text{Sin.}\, 59\frac{4}{5}'} - \frac{\text{Cos.}\, 4° 46' - \text{Cos.}\, 79° 46}{2\,\text{Sin.}\, 1° 30'}}{\text{Sin.}\, 79° 46'} =$$

$$\frac{-2{\cdot}493 + \frac{{\cdot}82234}{{\cdot}03480} - \frac{{\cdot}99654 - {\cdot}17766}{{\cdot}05236}}{{\cdot}98409} =$$

$$\frac{-2{\cdot}493 + 23{\cdot}630 - 15{\cdot}637}{{\cdot}98409} = \frac{+5{\cdot}500}{{\cdot}984} =$$

5·59. Hence, the new origin is 5·59 chains, *back* upon the tangent line AX; and consequently, in this instance, the new *curve* will *intersect* the first curve AF.

Case II. When $\propto$, v, and z, are given; to find T′.

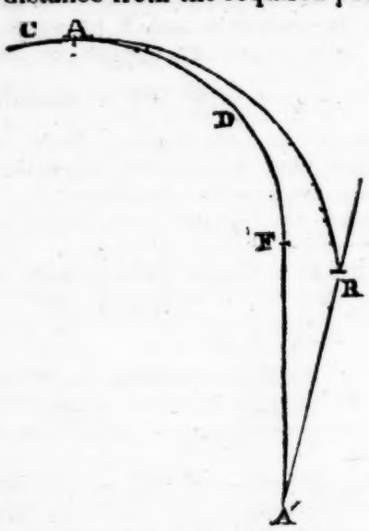
Let the quantity $2m\text{T}'$ be represented by D; and the following expression will be immediately derived from (XXXI.):

$$\text{D} = 2n\text{T} - z. \qquad \text{(XXXIV.)}$$

The value of D will be thus made known; and by an obvious transposition of the first equation (XXXII.), the following formula will then obtain:

$$\text{Sin. } T' = \frac{1 - \text{Cos. } D}{2 \propto \cdot \text{Sin. } D - 2v \cdot \text{Sin. } z + \frac{\text{Cos. } z - \text{Cos. } D}{\text{Sin. } T}}. \quad \text{(XXXV.)}$$

Having computed the value of T′, the quantity m, which denotes the number of chains contained in the new curve, will be made known by the formula, $m = \frac{D}{2T'}$. This will, however, be accurately true, only when m is an *integer* number, for reasons already explained in art. 5; but the formula (XXXV.) is, nevertheless, obviously rigorous. When the formula $\frac{D}{2T'}$ does not express an *integer* number, it will be, most generally, convenient in practice to take for the value of m the nearest integer number *greater* than $\frac{D}{2T'}$; and then, after tracing every chain in the new curve *except the last*, let that last chain be laid from a modulus of curvature expressed by the formula, $\frac{1}{2} D - T' \times \overline{m - 1}$; which will restore the proper *direction* to the new tangent, agreeably to principles evident enough from (IV.), and it will not vary, laterally, any material distance from the required position.



Example. Let CADF be a curve whose modulus of curvature is 1° 30′; and let A be a station in that curve, 25 chains from the extreme station F. From F, suppose a tangent FA′ to be laid 30 chains to a point A′. It is then proposed to determine the necessary change of curvature at the station A, in order to trace a new curve AR, such as to pass into a new proposed tangent RA′, intersecting the former at the point A′, and whose inclination to the common tangent at the station A, *exceeds* that of the tangent FA, by 4° 46′.

Here, T = 1° 30′, n = 25, v = 30, $\propto$ = 0, and z = − 4° 46′; therefore by (XXXIV.), D = 2nT − z = 75° + 4° 46′ = 79° 46′. Hence, by (XXXV.), Sin. T′ =

$$\frac{\cdot 82234}{+ 60 \times \cdot 08310 + \frac{\cdot 99654 - \cdot 17766}{\cdot 02618}} = \frac{\cdot 82234}{4 \cdot 986 + 31 \cdot 278} = \frac{\cdot 82234}{36 \cdot 264}$$

= ·02267; or, T′ = 1° 18′ = modulus of curvature necessary to trace the required curve AR, agreeably to the principles explained in art. 9. Now, in this instance, $\frac{D}{2T'} = \frac{79° 46'}{2° 36'} = \frac{79 \cdot 767°}{2 \cdot 6°} = 30 \cdot 68$; which is not an *integer* number, and the new curve AR must therefore be made to consist of 31 chains, of which the first 30 will be laid agreeably to the modulus of curvature, 1° 18′. And then, $\frac{1}{2}$ D − T′ × $\overline{m - 1}$ = 39° 53′ − 1° 18′ × $\overline{31 - 1}$ = 39° 53′ − 39° 0′ = 0° 53′ = necessary modulus of curvature for the 31st chain.

[From Porter's Chemistry of the Arts.]

FURNACES IN GENERAL.

(Continued from page 38.)

The Chamber.—The situation of the chamber varies much, and gives certain denominations to various furnaces. In some furnaces the chamber and fire-room are united; and even in this case there are several variations, for sometimes the substances to be acted upon are mixed with the fuel, and that either in alternate beds, one on the other, as in lime and brick-kilns, or the fuel and the other materials are thrown alternately in at the mouth of the furnace, as in the blast furnaces in which iron ore is smelted. In other furnaces, the vessels containing the materials are either placed circularly round the fire next the well of the fire-room, as in glass-house furnaces, and those in which spelter is distilled, and brass made; or else the vessel is placed in the centre of the fire, and entirely surrounded with fuel on the top as well as on the sides, as in the furnaces of founders and casters of metals. This latter disposition has received amongst practical writers a peculiar denomination, namely, that of a wheel-fire, or ignis rotæ. The chamber, when it forms a separate part from the fire-room, admits of three variations; for sometimes it is over the fire-room, sometimes on the side, and

sometimes it is placed in the centre, and surrounded with several fire-rooms.

The chamber is placed over the fire-room in the furnaces used with pots, kettles, common stills, and the boilers for producing steam. These vessels in general hang down from the mouth of the chamber, which is placed directly over the fire-room, and there is a sufficient space left between the vessel and the walls of the chamber, to allow the free passage to the vent of the air that has passed through the fire. The breadth of this space is usually left to the judgment of the bricklayer; the horizontal area of it ought to be equal to that of the free space between the bars of the grate, which is the radix from whence all the proportions of the different parts of a furnace are to be calculated. Hence, if it be required to determine the space to be left between the outside of a cylindrical pot, boiler, or still, and the wall of the furnace, first find the area of the horizontal circular section of the vessel, measured on the outside by any of the methods in use for that purpose, (which may be seen in Mr. Nicholson's Operative Mechanic, page 694, or any treatise on Mensuration;) and to this area add that of the free space between the bars of the grate, the sum will be the area of the circle to be formed by the internal side of the wall; the diameter of which being found, the difference between this diameter and that of the vessel being halved, will be the breadth of the space to be left between the vessel and the wall of the furnace.

In these kinds of furnaces there is seldom any contraction or throat between the fire-room and the chamber in which the vessel hangs. Curaudau has proposed to throw an arch over the fire-room, with a circular opening in the centre, and affirms that by thus contracting the space to which the full force of the fire is first applied to the vessel, it produces a more powerful effect; but there also arises this inconvenience, that this part of the vessel is liable to be burnt out before the other parts, so that frequent renewals of the vessel are requisite. When, indeed, the vessel is very large, it requires to have its bottom supported by pillars of masonry, so disposed as to allow a free passage for the air that has passed through the fire to get to the vent.

Furnaces with chambers over the fire-room are also used by tobacco pipe makers, and in the potteries. In these furnaces the roof of the fire-room is pierced with several holes, that the heat may be distributed as equally as possible through all the parts of the chamber.

In the furnaces used for roasting ore, and smelting them, as also in certain other operations, as in baking porcelain ware, the chamber is placed on one side of the fire-room. The communication in these furnaces is usually made by a single opening, but sometimes a series of holes are used. The larger furnaces used by the potters have a large central chamber, with four or six fire-rooms surrounding it, and opening into it by as many single openings. The metallurgists also sometimes use a central chamber with a fire-room at each end.

Many contrivances have been adopted for the purpose of introducing a supply of fresh air into the chambers of furnaces, to consume the smoke which is emitted in such quantities every time the fire is supplied with raw pit coal. A direct entrance into the chamber has the disadvantage of cooling it considerably, and is therefore not adviseable in any circumstances, and in addition to this the smoke itself is not thoroughly consumed by this method.

Several patentees have made channels in the masonry of the furnace leading from the top of the ash-pit, near the grate, into the chamber; and some have furnished these channels with sliders. Others have made channels in the walls of the fire-room, opening at one end to the external air, and at the other into the chamber. The object of these patentees being to supply the fresh air in a heated state, that it may accend the smoke, and thus cause its consumption; but as the furnace is always considerably cooled every time the door is opened to supply coal, the smoke is sometime before it will burn.

A still more powerful method of effecting this object has been lately proposed by Mr. Chapman, of Whitby. He causes the bars of the grate to be cast hollow, and when set in the furnace they open into two boxes, one placed in front, and the other behind the grate. In the front box, which is, of course, directly under

the stoking door, he has a register to admit more or less air at pleasure. The box behind the grate opens into an empty space, which is formed by making the bridge of the furnace double. Hence, when the register of the front box is open, there is a great draught of air through it, along the interior of the grate bars, thence into the space between the two walls of the bridge, and out of the slit at the top, where it comes in contact with the smoke, and as soon as the cooling of the furnace, by the opening of the door, is overcome, causes it to inflame and become a sheet of bright fire under the bottom of the boiler; but when a close hopper is used, and the introduction of cold air prevented, the smoke is entirely consumed from the first.

Opening into the Chamber.—An opening into the chamber is required in almost every case. This is very commonly at the top, being a circular hole in which the pot or still is hung. Sometimes it is on the side, as in those called English reverberating furnaces, used for roasting and smelting ores, or in potters' kilns.

It is seldom that these openings into the chambers have doors adapted to them, as they are closed either by the vessel, as in the first case just mentioned, or they are filled up at the commencement of each operation by means of slight brickwork, which is moved when the operation is performed.

Sometimes the opening into the chamber is left open, and actually serves in some cases as a vent, the usual vent being stopped.

The Vent.—The vent of the furnace has given rise to much difference of opinion as to the size it ought to have. Some make it large, to allow a free passage for the burnt air in the chimney; others again small, that the heat may not be dissipated and carried up into the chimney in waste.

It is generally a single opening, but in porcelain furnaces the manufacturers use a number of small openings instead of a single vent, with the view of assisting in the equal distribution of the heat throughout all parts of the chamber: and this practice should be adopted whenever this equal distribution is requisite. These artists are also careful that the sum of the areas of these holes should be exactly equal to that of the throats by which the flame and heated air enters into the chamber. It seems, therefore, adviseable in all cases, to make the vent or vents equal in area to that of the free space left between the bars of the grate.

The situation of the vent is usually at the top or back of the furnace; but there results a very great inconvenience from its being situated in the latter position; since, when the feeding or stoking doors are opened to supply fresh fuel, or manage the fire, a strong indraught of cold air takes place, which rushes over the surface of the fire, and not only cools the whole interior of the furnace, and prevents the accension of the vapor from the raw fuel, thus causing the production of smoke and soot, but also cools the vessels and materials exposed to the action of the fire; and when the vessels are made of glass, pottery ware, or cast iron, frequently cracks them, unless they are defended by a thick coating of lute, which necessarily diminishes the heat that can be applied to the materials contained within them.

Mr. Losh, already mentioned as a considerable improver of the construction of furnaces, has therefore proposed to remove the vent to the front of the furnace, immediately over the feeding or stoking door, and to conduct the burned air through channels made in the masonry, into the flue of the chimney. A great advantage attends this construction, that when either of the entrances into the fire-room are opened, the indraught of air, instead of rushing over the surface of the burning fuel, and striking against the vessels and materials, instantly passes up the vent, and does not enter at all into the interior of the furnace, whence this is much less cooler than in the furnaces of the usual construction.

As the entrance of air into the furnace is regulated by sliders and other contrivances, so, in many furnaces where this is neglected, its outlet is regulated by a damper or slider placed at the vent, by which its opening into the flue is altered at pleasure, and may be even stopped entirely: but it is far preferable always to have a door to the ash-room, or entrance for the air, and regulate the fire by it.

The Chimney or Flue.—The chimney

or flue is one of the most important parts of a furnace, and yet, in general, the least attended to, being usually made much too large in its horizontal area. By making it thus large, the draught through it is much diminished, and the soot collects and becomes troublesome; for when the sides of the flue contain a larger surface than can be duly heated, the necessary rarefaction of the air passing through it is destroyed. On this principle, alone, the draught of chimneys depends; and the cavity being too large proportionably to the current of air, the force of it is so diminished that the soot, instead of being blown out, gathers and rests on the sides till it obstructs the passage, and choking up the draught deadens the fire; especially at the first lighting of it, by which means the progress of the operation is sometimes greatly retarded. Instead, therefore, of the large proportion now made use of, if the chimney be intended for the use of one furnace only, an area equal to that of the free space between the bars of the grate is fully sufficient; and this may be increased in proportion where it is designed for a greater number.

The Reverend Mr. T. Ridge has observed, that if a recess is left at the bottom of the flue, below where the vent of the fire-place enters it, the soot collects in this recess, and the fouling of the flue is proportionally prevented.

This recess or well might have an opening made into its lower part, which, being opened occasionally, the soot might be extracted without the necessity of ascending the flue.

It is well known, that when flues are carried horizontally, for the purpose of connecting a furnace with the upright shaft of a chimney, they fill very fast with soot, the draught through them can scarcely be maintained, and they are even apt to burst. On adding a recess on this principle to a horizontal flue, all the soot collected in the recess, and the flue was scarcely soiled. A single flue is sometimes made to serve for several furnaces, which is advantageous when a number of furnaces are in constant action, so as to keep the mass of the chimney at a sufficient heat, that the ascensional force of the air which has passed through the fire, is not diminished by cooling. But unless this condition can be maintained, separate flues for each furnace will be most advantageous.

All the furnaces attached to a single flue, which are not in use, must be kept close shut up, or, at least, the dampers at their vents, if they have this apparatus, closed, otherwise a false draught will take place, and the cold air passing through them will cool the flue, and diminish the heat of the furnaces that are in action.

The stability of the chimney against the action of the wind, when it stands separate from other buildings, requires that it should have a sufficient breadth of base. The calculations of Mr. Tredgold, in the supplement to the Encyclopædia Britannica, show that each side of a chimney, having a square basis, or the narrowest side if the basis be rectangular, should be at the least one foot in breadth for every ten feet in height; and the area of the flue ought not to exceed one third of the area of the chimney.

The chimneys of our common domestic fire-places have their upper terminations enlarged by the addition of a circular chimney-pot, which circumscribes their square flue. This enlargement is vulgarly, but erroneously, called a contraction, by those who look only to the external appearance, without considering the greater thickness of the brick-work in respect to the sides of the pot; and is supposed to increase the draught of the flue.

With the same view, the chimneys in Venice are terminated by pots which are of a conical form, much wider at top than at bottom. From the experiments of Venturi on the flowing of fluids through pipes, it would appear that this construction was preferable to our own chimney-pots, which are, on the contrary, rather narrower at top than at bottom. In describing the fourneau lithogeognosique of Dr. Macquer, an occasion will be had to relate an experiment of M. Guyton de Morveau, relating to adding a conical flue widening at top to this furnace.

When the chimney has attached to it furnaces which give a great heat, and of course have a strong draught, the ascensional force of the heated air will overcome the action of the wind, unless it blows a perfect storm. But in chimneys attached to furnaces of no powerful ac-

tion, the wind frequently prevents the exit of the burned air, and thus diminishes the power of the fire. Hence all chimneys should have the top of their side walls sloped upwards from the outer surface to the inner, in order that the wind impinging on the top may be deflected upwards, and thus assist in drawing out the smoke and burned air.

The wall of chimneys is usually single, but when the air which passes up the flue is very hot, it has been found preferable to have the wall double, with an empty space left between the two, which are tied together from space to space by bricks passing from one to the other.

Velocity of the Draught.—It might be supposed that the velocity of the draught through furnaces would long ere this have been reduced to calculation. Yet this is not the case, and the various measures of it by the several mathematicians who have investigated the subject, differ in an astonishing degree. They all, indeed, proceed upon the principle of the acceleration of velocity in falling bodies, and the usual theorems of hydrodynamics, but vary very considerably in the application of them.

The mathematical investigation of this apparently simple question may be divided into two classes. Most of them found their calculation on the compound ratio of the acceleration produced by the height of the chimney, and of difference in specific gravity between the external air of the atmosphere, and that in the flue of the chimney; and yet even these do not agree in the results they obtain. On the other hand, Mr. Davis Gilbert, whose fame as a mathematician of the first rank is unimpeached, stands alone, as he grounds his calculation on the velocity with which atmospheric air rushes into a vacuum, or any medium of less density than itself.

They equally differ as to the place where the temperature of the heated air shall be taken to compare with that of the atmosphere: as the generality of writers take the temperature from the top of the chimney, where the heated air rushes out into the atmosphere: while Mr. Davis Gilbert in this point varies from his brethren in choosing the temperature of the hottest part of the furnace for the groundwork of his calculation.

Taking then, as an example, a furnace adapted for melting copper, with a chimney forty feet higher than the half or average height of the entrance for air, the temperature of the hottest part of which is 1500 degrees of Fahrenheit, and that of the air issuing from the chimney 123 degrees of Fahrenheit, and that of the external air 40 degrees of the same scale. If we calculate the velocity according to the principles of M. Montgolfier, who is the first author who investigated the subject as they are laid down by M. Payen in the Dictionnaire Technologique, namely, that the draught is equal to the velocity that would be acquired by a heavy body in falling through a space equal to the simple difference of the height of two similar columns of air standing upon the same base, the one of the air of the external atmosphere, and the other column of the air in the chimney, of the same height when hot, but reduced by cooling to the temperature of the atmosphere. Now, according to this hypothesis, the heated air will pass out of the chimney with a velocity of 10 feet .19 in each second of time.

Another mode of calculation has been given in the article "Furnaces," in Rees' Cyclopædia, grounded upon Mr. Atwood's theorem, which leads the writer of that article to divide the difference of the specific gravity of the heated air and external air by their sum, the quotient multiplied by the velocity which a falling body would acquire, by falling freely through the height of the chimney, will, it is said, give the velocity of the current of air through the flue. But this velocity will, the writer thinks, be double the real velocity, on account of the retardation which the current experiences by the friction against the sides of the flue. Now, if this mode of calculation be pursued, the velocity of the air issuing from a furnace of this kind will be 3 feet .88 in a second of time; so that if the half of this calculated velocity be taken for the real velocity, it will be 1 foot .94.

Passing over for the present the calculations of Mr. Davis Gilbert, as being founded upon a totally different hypothesis, the next author who has considered the subject is Mr. Sylvester, in the Annals of Philosophy, for June, 1822. He refers to Mr. Davis Gilbert's calculations, and conceives that the hypothesis on

which he proceeds must be erroneous, because it produces for its result a velocity which far exceeds that of heavy bodies falling freely in a vacuum, whereas the resistance of the medium must produce some retardation of this velocity.

According to Mr. Sylvester, the velocity of the current of heated air will be equal to the difference between the specific gravity of the cold external and heated internal air, divided by the specific gravity of the cold external air, and the quotient multiplied into the acceleration of velocity that would be acquired by a body falling the height of the chimney. Whence, on the preceding data, the velocity would be 7 feet .74.

In a recent work written by Mr. Tredgold, he has given very elaborate formulæ for calculating the draught of ventilating pipes, and the chimneys of furnaces. He assumes the force whereby the current ascends, to be equal to the height of the chimney, multiplied by the expansion the air suffers from the increased temperature to which it is subjected, and that the velocity is equal to the square root of sixty-four times the force, from which velocity three-eighths, or even one half, must be deducted on account of contractions, eddies, bends, and friction.

Now, on this hypothesis, the theoretical velocity of the current of air in the flue of a furnace of this kind will be equal to 18 feet .9; from whence, deducting one half, the actual velocity is probably nine feet and a half.

Hence, although these mathematicians all proceed upon nearly the same theory, still great discrepancies exist in their results. According to Montgolfier's calculations, the velocity of the draught in every second of time is 13 ft. .91; the writer in Rees' Cyclopædia, 1 ft. .94; Mr. Sylvester, 7 ft. .73; Mr. Tredgold, 9 ft. .50.

But these differences vanish entirely before the calculation of Mr. Davis Gilbert, in the Quarterly Journal of Science, for April, 1822. According to this gentleman, the rarefaction or expansion of the air by the heat being ascertained, by raising the fraction $\frac{431}{480}$ to the power whose index expresses the difference of temperature, and the density or specific gravity of the burned air, as compared with that of the external atmosphere, which Mr. Gilbert states at 1.0874 to 1, the expansion divided by the specific gravity of the burned air will show the specific gravity of the air within the chimney.

The tendency to ascend will, he says, be equal to the difference between this specific gravity and that of the atmosphere multiplied by the quotient obtained by dividing the height of the chimney by the height the atmosphere would have if it were of uniform density throughout, which is assumed by Mr. Gilbert to be 26058 feet. The square root of this product is to be multiplied by the velocity with which the atmosphere would rush into a vacuum, namely, 1295 feet in a second of time; and the product divided by the square root of the specific gravity of the lighter air will give the velocity.

Now, according to this hypothesis, the velocity of the air passing through the above mentioned furnace would be no less than 225 ft. .67 in a second of time, which, being equivalent to 153 miles in an hour, is about five times the velocity of the wind in a full storm.

It would appear from the immense discrepancy between these calculations of the velocity by the most eminent mathematicians, that every attempt to reduce the question to mathematical calculation, has hitherto proved utterly abortive, and has left the subject in as much obscurity as ever. Thus much seems certain, that if any smoking or fuming body be held near the entrance of the air into a very powerful melting furnace, when in full heat, the velocity with which the smoke or fume is drawn into the furnace seems by no means so rapid as might be expected on the calculation of Mr. Davis Gilbert. Mr. Haycroft observes, that the heat in blast furnaces does not increase merely in the ratio of the fuel consumed, but in some compound ratio; and that even in air furnaces, those through which the greatest quantity of air passes in a given time, consume a proportionably less quantity of fuel to produce the same effect.

Annoyance of Smoke.—It has been already seen how many contrivances have been had recourse to for preventing the annoyance of the smoke, so plentifully emitted by raw pit coal, when suddenly heated, without the contact of a sufficient

quantity of heated air; and to this nuisance there are frequently superadded those of arsenical and sulphureous vapors, volatilized metals, and other matters, which spread widely around the works wherein they carry on the smelting of metals.

In the German mineral works, a long and large horizontal flue is interposed between the vent and the ascending flue of the chimney, in which the arsenical vapors are condensed and collected for sale; but this is not always practicable, nor would it be always sufficient.

Mr. Jeffreys, of Bristol, has proposed a plan for avoiding this nuisance of arsenical fumes, and which may also be employed to condense and collect the smoke. His plan is to build two flues, either contiguous, or at any distance from one another, but connected at top by a horizontal flue. The second flue is covered with a cistern, whose bottom is pierced with a number of small holes, like a common cullender; and this second flue has at the bottom an opening on the side to let out the water that runs down it.

Now, when the furnace is used, water is let on to the cistern at the top of the descending flue, which immediately runs in small streams through the holes in the bottom, which divide into drops as they fall, and carry down air with them, produce a considerable draught through the flues, differing from the draught produced by bellows, or ordinary blowing machines, by being applied behind the fire, and drawing instead of pushing the air through it.

This shower of water, as soon as it intermingles with the smoke and vapor of the fire, also immediately condenses and mingles with them, carrying them down, so that they run off with it through the opening at the bottom of the flue.

The efficacy of this mode has been completely established by experiment. The draught of air through the furnace was prodigiously increased; and although the ascending column of smoke was rendered as dense and black as it could well be made, yet not a particle of smut or smoke was observed to escape by the vent at the bottom of the water flue. A strong current of air and a stream of black water issued forth, but nothing like smoke.

Though advantage may be derived in various ways from the application of this invention, and more especially where the expense of carrying it into effect bears but a small proportion to the advantages that will accrue, still, it may be expected, that many instances will be found in which the difficulty or expense of procuring the necessary supply of water, and possibly other causes, will operate as a total bar to its adoption. On the other hand, it is not improbable that time and reflection may discover remedies which at the outset may not occur; thus, when the furnace is used to heat a steam boiler, a part of the power may be expended in raising water for this purpose.

Conical Dome.—In some chemical works the laboratory itself is the real chimney of the furnace, and is used to produce the necessary draught, as in glass-houses and potteries. In these manufactories a large conical dome surrounds the furnace at some distance, so as to allow the workmen free access to it. This dome is carried to a considerable height, and surmounted at top by a short cylinder. The air then being admitted into the furnace from a vault under ground, passes through the fire, and out of the fire-room or chamber into the dome by several openings above the level of the workmen's heads; and as no more air is admitted into the dome by the doors than is absolutely necessary for the respiration of the workmen, the fire receives nearly the full benefit of the velocity of draught produced by the height of the dome.

Chemists have sometimes endeavored to imitate this construction in their small experimental laboratories, when they had only a wide recess with a single flue, like those formerly used in English kitchens, and still in farm-houses, for their chimney. To obtain a great degree of heat in their wind furnace, although its proper chimney rose only two or three feet high, they fitted a pipe of three or four inches diameter to the ash-room of their furnace, and passed the other end through the wall of the laboratory; this end was sometimes widened into a kind of funnel.

As mere practical chemists have seldom much knowledge of hydrostatic and pneumatic theories, many have complained that they did not receive the be-

nefit they expected from this air pipe. This was because they neglected the necessary conditions for its proper action; which are, first, that the ash-room door be closely stopped, so that no air may pass the fire but what comes through the pipe; secondly, that the windows and doors of the laboratory be accurately closed, and even paper pasted over the crevices to prevent any entrance of air through them to create a false draught up the chimney; and lastly, that the door be not opened during the process, unless the operator be much distressed in his respiration, and then only for a moment. By these precautions being taken, the laboratory becomes a part of the chimney, and the full effect of its height is produced.

Blast of Air.—The introduction of a blast of air into furnaces, instead of depending upon their own draught, is used when it is not convenient to construct a chimney of sufficient height to produce the intended effect, or when it is desired to obtain this effect in a shorter space of time than would be required in air furnaces, as these last take a considerable time before they attain their full draught, by the mass of masonry of which they consist carrying off a considerable portion of the heat, until it becomes so well heated as to require no farther addition, except to supply that portion which passes through the walls themselves.

Two methods have been employed to produce this artificial blast. The oldest is probably the water blast, or that produced by the air, which is carried down by a shower of water made to fall a sufficient height. As this fall could not always be obtained where a blast was wanted, recourse was had to bellows of various construction, and blowing machines.

On both these methods the blast, as originally produced, is more or less unequal, and requires regulation. Three methods are used for this purpose: in the one, the blast, as it issues from the machines, is introduced into a chamber of very great size, either constructed of iron plates, or masonry, or cut in the substance of a rock, by which means the unequal blast of the machines is equalized, and it issues out at the other end in a regular stream.

In the second method, the blast is thrown into a vessel with a moveable top, sliding up and down in it at pleasure, it being kept horizontal by an iron standard or rod rising from its centre and passing through a hole in a cross-piece fixed above the vessel. This sliding moveable top is loaded with as much weight as is judged necessary. The blast, then, being sent into this regulator, as it is called, raises the moveable top, and the weight placed on it regulates the strength of the blast.

In a third method, the blast is first thrown into a large vessel of wood or iron plates, opened at bottom, closed at top, and fixed in a large cistern of water. Here the water being driven out by the blast, rises in the cistern, and by its pressure regulates the blast to the furnace.

Provision to be made.—Previous to *building furnaces*, it is necessary to provide the iron work necessary in their construction, that no delay may take place.

An iron door with its frame, for the lighting of the fire, and taking out the *scoria* of the coals, is requisite for most kinds of them; but as such doors are commonly intended for the farther use of feeding the fire with fuel, they are made much larger than is necessary. If that method be not used, it is yet proper always to have them as long as the fire-place, or area made by the bars. They need not, however, for ordinary furnaces, be more than four inches high, where they are not designed to serve for feeding the fire. For the lower they are, the less they will be capable of injuring the proper draught of air through the fuel, by making a false one, and the less liable also they will be themselves to warp, and be out of order. They should be made of hammered iron, lined with a plate of cast iron well rivetted to the other. The usual form will very well serve, if the latch to keep them shut be made bigger than common, and carried across the whole door, to give it strength to resist the weight of the fuel, which otherwise, when the iron is softened by violent heat, forces the middle part outwards.

A proper cast iron frame is necessary to be provided for the hole through which the fire is to be fed with fuel, when that method of doing it is followed. The frame must be made of the size and form of the hole, which, in middling-sized

furnaces, may be four inches wide, and three high, or bigger where the furnace is large. The bottom plate should project six or eight inches beyond its joining with the side plates, and be four or six inches wider, in order to form a slab on which the stopper or stopping coal may be laid. This stopper is usually a brick, which does full as well as any other thing. The frame itself may be merely a slab of cast iron, about a foot square, or even a tile of that dimension, and the top and sides formed of wrought iron bars, bent into the proper form.

Plates and broad bars are also generally wanted, to be laid where brick-work is to be raised over the hollow parts of furnaces. Where larger plates are required, the cheapest and best way is to have them cast of the exact dimensions wanted. But, when a broad bar or two, laid together, will answer the end, the easiest way is to have them cut off of a proper length, from the bars of hammered iron at the ironmongers. The right proportion of them may be easily computed, by estimating the proportion of the parts of the furnace they are to be subservient to, which should be always carefully done, and the workmen should be apprised, by written instructions, and drawings, of the size and measure of every thing they are to erect or put together.

In chemical manufactories, the proprietors should contrive to continue their processes night and day, or if that is not practicable, they should stop all the openings in the furnace so close as to prevent the furnace from cooling during the night. Furnaces thus kept constantly hot will last six or seven times as long as those will do which stand frequently idle. The contraction of the materials during the time of cooling, alternating with their expansion when they are again put into use, wear them out very rapidly.

When this continual use of the furnaces cannot be adopted, some chemists, in order to make them last longer, bind them with iron bars, either screwed together, or fastened by loops and wedges; others, taking advantage of the cheapness of east iron in England, enclose them in cases of that metal, cast for the purpose, with proper openings, the several parts of which case are screwed or pinned together.

For common furnaces, thin flat bars of tough iron, about eight inches longer than that part of the furnace where they are to be inserted, slit for four inches at each extremity, and the ends turned up, are built in each alternate course round the fire-room and chamber, by which means the expansion of the furnace is attempted to be checked, and its retraction secured.

The usual method of bricklayers building in pieces of small hoop iron between the courses of brick, is a ridiculous absurdity. Nor should a chemist allow them to plaster over his furnace, or surround their edges with cloth, or sheets of lead. If there be fear of the edges getting chipped by pails, or other vessels, let them be surrounded with an iron hoop, or if this should be prejudicial to the materials which may be at times dragged over them, then the edges may be made of a wooden curb, fastened together with tree-nails.

Experiments on the Transverse Strength and other Properties of Malleable Iron, with Reference to its Uses for Railway Bars. By Peter Barlow, F. R. S., Cor. Mem. Inst. of France; of the Imp. and Roy. Acad. of Petersburgh and Brussels, etc.

[Continued from page 68.]

This want of stiffness is, I should imagine, but badly compensated by the trifling saving of metal thus effected; for I find that an addition of little more than four pounds per yard, would convert this rail into a rectangular one of the same depth, which would have one-third more stiffness at its middle point, and probably one-half more a little beyond the middle of the half-lengths. I am aware, objections are made to rectangular bars having so much depth of bearing in their chairs, and this may be a practical defect, on which I shall offer no opinion; at all events, it is well to estimate properly both evils, and then to choose the least.*

Having thus satisfied myself on the nature of the fish-bellied rail, I proceeded with my experimental inquiries, which I have divided into the following sections:

1. To determine the extension of an iron bar of given area, under different degrees of tension; and hence the force with which

* It will be seen in a subsequent page, that by introducing what is called a lower web, that, weight for weight, a parallel rail may be made as strong as the fish-bellied, with only an additional depth in the chair of three-quarters of an inch.

the same bar will contract with a given reduction of temperature.

2. The comparative resistance of malleable iron to extension and compression, and thereby the position of the neutral axis.

3. The figure of the area of section, which gives the greatest strength with the same quantity of metal.

4. The strains which bars of given sections are capable of sustaining without injury to their elastic power.

Experiments to determine the quantity which iron extends under different degrees of tension.

Fig. 1.

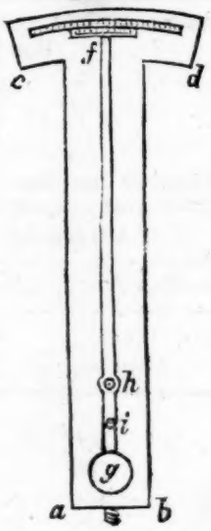


Fig. 2.

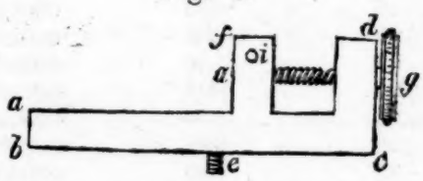
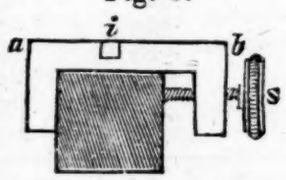
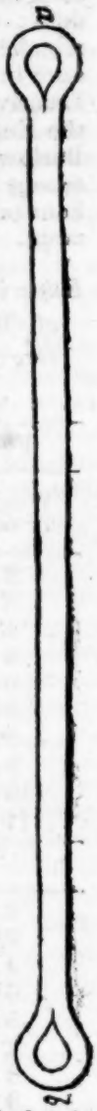


Fig. 3.



With a view to this inquiry, an instrument was made as in the annexed sketch, fig. 1. *a b c d* is a piece of brass, about one-fifth of an inch thick, having an arc at top, divided into tenths of inches; *h f g* is a hand, with a vernier, turning freely on a centre *h*; and *i* is a steel pin, about half an inch long, projecting perpendicularly forward; the distances *f h* to *h i* being as 10 to 1. *e* is a small end with a screw, for the purpose described below. *a b c d*, fig. 2, is another piece of brass, having a screw *e*; *f* is a piece working in a dove-tail, adjustable for position by the screw *g*, and *i* is another steel pin projecting forward. *a b*, fig. 3, is an iron saddle-piece, with a set screw *s*; and at *i* a hole is tapped to receive the screw *e*, fig. 2; and another saddle piece, exactly like this, is made to receive the screw *e*, of fig. 1.



The iron bars intended to be experimented on were made of the annexed form, about ten feet in length; these, by proper bolts and sheckles, were fixed at *a* and *b* in the proving machine;* the two saddle pieces were then fixed on at the exact distance of 100 inches; the instruments, fig. 1 and 2, screwed into their respective saddle pieces, and a light deal rod hung, by means of two small holes formed in it, (also at the distance of 100 inches,) upon the two pins *i i*; and then by means of the set-screw, fig. 2, the vernier of fig. 1 was adjusted exactly to zero. The pump of the hydraulic press was now put in action, and after one, two, or more tons pressure were on, according to the size of the bar, and every thing brought well to its bearing, the hand was again adjusted to zero, after which the index was read for every additional ton. Here it will be seen, that whatever the bar stretched between the two instruments, the lower pin of fig. 1 was drawn forward, and the index-end thrown back ten times that amount, consequently to ten times the actual amount of the quantity stretched.

It has been observed, that after one, two, or more tons strain were applied to bring every thing well to its bearing, the index was adjusted to zero, and its reading afterwards carefully registered as each additional ton was added. The strain during the experiment was repeatedly let off, and the index was found to return to zero, till the strain amounted to about nine or ten tons per inch, when the stretching became greater for each ton, and the bar did not

* The Lords Commissioners of the Admiralty having been pleased to allow me any facilities His Majesty's Dock-yard at Woolwich afforded for conducting these experiments on a proper scale, the proving machine here referred to is an hydrostatic press, constructed by Messrs. Bramah's, principally for the purpose of testing or proving the iron cables, before they are issued for service. It is an excellent machine of its kind, is capable of bearing a strain of 100 tons, and is very sensible to a difference of strain of 1-8th of a ton.

any longer regain its original length when the strain was removed, its elasticity with this tension being obviously injured.

These experiments required more attendance than it was possible for one person to give; the adjustment of the weights, the reading and registering the index, required each the undivided attention of one individual; the pumping also required to be watched with care. And I have great pleasure in acknowledging the ready assistance I received from Messrs. Lloyd and Kingston, the Engineers of the yard; from Mr. P. W. Barlow, Civil Engineer; as also from Lieutenant Lecount, who came from Birmingham to witness and assist in the experiment.

Experiments on the Longitudinal Extension of Malleable Iron Bars, under different Degrees of direct Tension.

TABLE I.

Feb. 21—Bar No. 1, 1 inch square.

Weight in tons.	Index Readings.	Parts of the whole Bar extended by each ton.
2	zero	
3	·0625	·0000625
4	·156	·0000935
5	·265	·0001090
6	·375	·0001100
7	not observed	mean.
8	·562	·0000935
9	not observed	mean.
10	·750	·0000940
11	·875	·0001250

Bar No. 2, 1 inch square.

2	zero	
$3\frac{1}{2}$	·11	·0000733
4	·15	·0000800
5	·24	·0000900
6	·35	·0001100
7	·44	·0000900
8	·52	·0000800
9	·62	·0001000
10	·70	·0000800
11	·81	·0001100
12	1·13	Elasticity injured.

Feb. 23—Bar No. 3, 1 inch diameter.

1	zero	
2	·16	·0001600
3	·31	·0001500
4	·44	·0001300
5	·56	·0001200
6	·67	·0001100
7	·79	·0001200
8	·91	·0001200
9	·103	·0001200

Bar No. 4, 1 inch diameter.

Weight in tons.	Index Readings.	Parts of the whole Bar extended by each ton.
1	zero	
2	·15	·0001500
2	·28	·0001300
4	·42	·0001400
5	·56	·0001400
6	·69	·0001300
8	·79	·0001000
7	·97	·0000800
9	·116	Elasticity destroyed

Mean extension per ton, per square inch,

Bar No. 1.	·0000982
No. 2.	·0000903
No. 3.	·0001010
No. 4.	·0000976
Mean of the four	·0000967

TABLE II.

Feb. 28—Bar No. 5, 2 inches square.

Weight in tons.	Index Readings.	Parts of the whole bar extended by each 4 tons.
4	zero	
6	·100	
8	·180	·000180
10	·240	·000140
12	·290	·000110
14	·350	·000110
16	·400	·000110
18	·450	·000110
20	·500	·000100
22	·550	·000100
24	·600	·000100
26	·650	·000100
28	·695	·000095
30	·740	·000090
32	·790	·000095
34	·825	·000085
36	·860	·000075
38	·920	·000095
40	1·05	·000145
		Elasticity exceeded.

Bar No. 6, 2 inches square.

4	zero	
6	·090	
8	·150	·000150
10	·210	·000120
12	·250	·000100
14	·290	·000080
16	·335	·000085
18	·375	·000080
20	·410	·000075
22	·445	·000070
24	·485	·000075

Weight in tons.	Index Readings.	Parts of the whole bar extended by each 4 tons.
26	·525	·000080
28	·565	·000080
30	·620	·000095
32	·660	·000095
34	·730	·000110
36		Full elasticity.
38		
40		

March 7—Bar No. 7, 2 inches square.

4	zero	
6	·065	
8	·125	·000125
10	·175	·000110
12	·230	·000050
14	·280	·000050
16	·335	·000050
18	·385	·000105
20	·435	·000100
22	·480	·000095
24	·530	·000095
26	·575	·000095
28	·625	·000095
30	·670	·000095
32	·715	·000090
34	·755	·000085
36	·805	·000090
38	·850	·000095
40	·900	·000095
		Elasticity perfect.

Mean extension per ton, per square inch,

No. 5.	·0001082
No. 6.	·0000957
No. 7.	·0000841
Mean	·0000946
Mean of preceding Table	·0000967

Collecting the results of these seven experiments, and reducing them all to square inches, we find that the strain which was just sufficient to balance the elasticity of the iron, was in—

Bar, No. 1.	(re-manufactured iron)	10 tons.
" 2.	ditto	11 "
" 3.	new bolt	11 "
" 4.	ditto	10 "
" 5.	(re-manufactured)	9.5 "
" 6.	ditto, from old furnace bars,	8.25 "
" 7.	new bar, by Messrs. Gordon,	10 "

We may consider, therefore, that the elastic power of good iron is equal to about ten tons per inch, and that this force varies from ten to eight tons in indifferent and bad iron. It appears, also, (considering ·000096 as representing in round numbers $\frac{1}{10000}$th,) that a bar of iron is extended one ten-thousandth part of its length by every ton of direct strain per square inch of its section; and consequently, that its elasticity will be fully excited when stretched to the amount of one-thousandth part of its length.

Remarks on the foregoing Experiments.

These results have an important bearing on the question of railway bars. We shall see, in the following section, how they become applicable to the investigation of the transverse strain; but, at present, I shall only speak of them as they apply to the fixing of the rail to the chair. Amongst the numerous models which the Directors did Messrs. Rastrick, Wood, and myself, the honor to submit to our inspection, for the purpose of awarding their prize, there were several in which it was intended to fix the rail permanently to the chair—a very desirable object, if it could have been safely adopted; and it was the want of data to enable us to decide on this point, which first led me to propose this course of experiments. The question is now satisfactorily answered. We have seen that, with about ten tons per inch, a bar of iron is stretched $\frac{1}{1000}$th part of its length, and its elasticity wholly excited or surpassed. Again, admitting 76° to be the extreme range of the thermometer in this country between summer and winter, it appears, from the very accurate experiments of Professor Daniell,* that a bar of malleable iron will contract with this change $\frac{1}{2000}$th part of its length. And hence it follows, that if the rails were permanently fixed to the chair in the summer, the contraction in the winter would bring a strain of five tons per inch upon the bar, and a strain of twenty-five tons upon the chair, (the bar being supposed of five-inch section,) thereby deducting from the iron more than, or full half, its strength, and submitting the chair to a strain very likely to destroy it. Every proposition, therefore, for permanently attaching the rail to the chair is wholly inadmissible.

These remarks may also be carried still farther. If it be dangerous to attach the rail *directly* to the chair, it must be bad in practice to affix it *indirectly* by wedges, cotters, or otherwise, beyond what is absolutely essential to give it steadiness under the passing load; for it is evident, that if by these means we could prevent any motion taking place, we should fall into the same evil as by the permanent attachment; and if, as most probably will happen, we fail of entirely accomplishing this, still all the friction which is produced must be overcome by the contracting force of the

* See Phil. Trans. 1831.

iron, and be so much strength deducted from its natural resisting power.

The problem, therefore, which engineers have to solve, is, "To find a mode of fixing the rail to the chair, which shall give sufficient steadiness to the former; but which, at the same time, shall produce the least possible resistance to the natural expansion and construction of the bar."

The quantity of motion which thus takes place is certainly but small, viz. about $\frac{1}{11}$th of an inch between summer and winter, with a fifteen-foot bar; but the force of contraction is great, amounting to five tons per sectional inch for the annual extremes, and frequently to not less than two and a half tons between the noon and night of our summer season, while the whole power of iron within the limits of its elasticity does not exceed nine or ten tons.

This is an important consideration, and for want of attention to it, or rather, in consequence of its amount not having been ascertained, a practice of wedging or fixing the rails has prevailed, which must necessarily have been the cause of great destruction to the bars.

I would also suggest here, as a matter deserving the attention of practical men, that as the bar must necessarily contract, it will draw from that side which is least firmly fixed, and hence all the shortening will most probably be exhibited at one end, however slight the hold on either may be; and when it happens that the adjacent ends of two bars both yield, the space between the two is rendered double that which is necessary. To avoid this evil, one of the two middle chairs in each bar might be permanently attached to the rail, in which case the contraction must necessarily be made from each end, and the space occasioned by the shortening of the bars would then be uniform throughout, and much unnecessary and injurious concussion thus saved both to the rail and to the carriage.

Experiments to determine the comparative Resistance of Malleable Iron to Extension and Compression, and the position of the neutral axis in bars submitted to a transverse strain.

Let A B (see figure 1, on the following page,) represent an iron or any other bar supported at A and B, and loaded in the middle by a weight W, which deflects it; extending the fibres between n and $c\ d$, and compressing those between n and $c'\ d'$. Now, supposing the system in equilibrio, $\frac{1}{2}$ W acting at the extremity of the $\frac{1}{2}$ length, or $\frac{1}{4}\ l$ W, is equivalent to the sum of all the resistances to extension in $n\ c\ d$, and to all those of compression in $n\ c'\ d'$, each fibre acting on a lever equal to its distance from the neutral axis n. Consequently, as the quantity of extension of any fibre is as its distance from the neutral axis, and the lever by which it acts, being also as that distance, the actual resistance of a fibre at the distance, x, is as $\frac{x^2 t}{d'^2}$, t being the tension of the lower fibre, and d' its depth below the neutral axis; and the sum of all these resistances will be $\int \frac{t\ x^2 d\ x}{d'^2} = \frac{1}{3} d'^2 t$, (when $x = d'$), or for the whole depth. In the same way, c being taken to denote the compression of the upper fibre, corresponding to the tension t, the sum of all the compressions will be,

$$\frac{1}{3} d''^2 c,$$

d'' denoting the depth of compression; hence the whole sum is,

$$\frac{1}{3} d''^2 c + \frac{1}{3} d'^2 t = \frac{1}{4} \text{W}\ l;$$

but $d''\ c = d'\ t$,* the quantity of resistance being equal to that of extension; this, therefore, becomes

$$\frac{1}{3}\ d''\ d'\ t + \frac{1}{3}\ d^2 t = \frac{1}{4}\ l\ \text{W}, \text{ or}$$

$$\frac{1}{3}\ (d'' + d')\ d'\ t = \frac{1}{4}\ l\ \text{W}, \text{ or}$$

$$\frac{1}{3}\ d.\ d'\ t = \frac{1}{4}\ l\ \text{W}.;$$

d being the whole depth, and d' the depth of tension; whence,

$$d' = \frac{3\ l\ \text{W}}{4\ d\ a\ b} = \text{depth of tension, and}$$

$d - d'$ the depth of compression,

consequently, $\frac{d'}{d - d'}$ the ratio, in which the neutral axis divides the sectional area in rectangular bars.

Comparison of the Formula with Experimental Results.

In order to submit this formula to practical results, a strong iron frame was forged, of the form herewith shown (see figure 2); D C is thirty-six inches long, six inches broad, by two deep; the two arms two inches square, and the ends of proportional dimensions to those represented. The other view of the arms is represented in the side

* To prevent misapprehension, it may be proper to observe that c here is not intended to represent the force requisite to compress a fibre the same quantity that the force t extends it; but simply, the force of the compression at c, corresponding to the tension t on the lower fibre. The equation, therefore, $d''\ c = d'\ t$ is equivalent to saying that the sum of all the forces in $n' c'\ d$ is equal to all the forces in $n\ c\ d$; or that $a\ g = n\ a'\ g'$; a, a', denoting the areas, and g, g', the distances of the centres of gravity from n, and taking $n\ t$ to denote the force which will compress a fibre to the same extent as the force t will extend it.

Fig. 1.

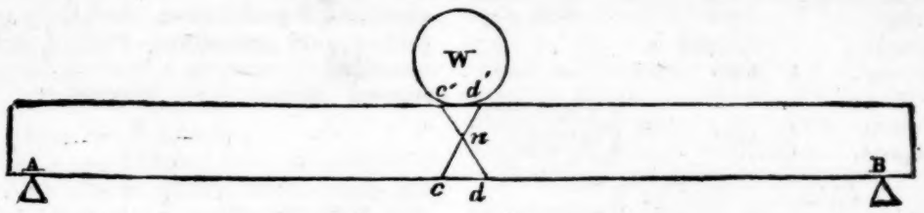
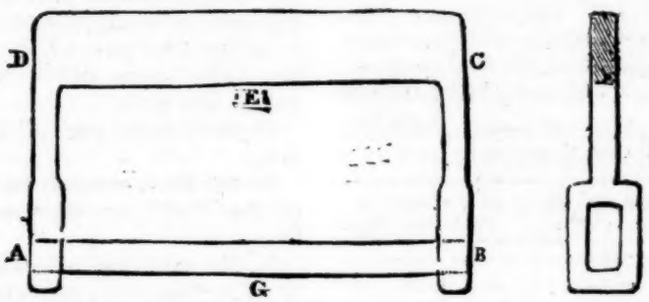


Fig. 2.



figure, with an opening six inches by three, in which the bars for experiment were placed, as represented by A G B; the space between is thirty-three inches. The shackles were applied at E and G, and connected by strong iron cables to the press; the strain was then brought on and the results recorded.

In order to measure with every requisite accuracy, the deflections which the bar sustained, as different weights were applied, an instrument of the form shown in the annexed figure was neatly and accurately

made in iron, having two feet, A D, B C; the centre was tapped to receive the brass screw, H S, of twenty threads to the inch, and the head was divided into five equal parts, and by again subdividing these divisions into ten, a deflection of $\frac{1}{1000}$ of an inch might be measured with great ease.

The method of applying it was to rest its feet on the bar, and then to retain it in its place by cramps and screws. The micrometer screw was then run down till it was in contact with the bar, and the divisions read and registered, either before any strain was on, or when the first slightest strain could be estimated, as stated in the following table.

The first six experiments were made on different parts of the bars, Nos. 5, 6, and 7, without cutting them, by introducing them into the iron frame above described (having thirty-three inches clear bearing,) and straining them till the successive deflections showed a tendency to increase in amount, which was taken as a sign of the elasticity being injured; and the amount of this strain having been previously ascertained by the former experiments, they furnish the best possible data to apply to the formula for determining the position of the neutral axis.

Experiments made to ascertain the Deflections due to different Transverse Strains, and the Weight which first produces a Strain equal to the Elastic Power, and thence the position of the Neutral Axis.

TABLE III.

PART 1. BAR No. 5.

Bearing 33 Inches. 2 Inches Square.

Weight in tons.	Readings by Scale.*	Deflections for each half ton.	
No Weight.	1·96		
·875	1·92	·023	
1·00	1.90		
1·50	1·90	·016	
2·00	1·88	·020	
2·50	1·86	·020	
Weight removed.	returned to 1·96		
3·00	1·80		Elasticity injured.
Weight removed.	1·88		

PART 2. BAR No. 5.

No Weight.	1·95	
·750	1·92	·020
1·00	1·91	·020
1·50	1·89	·020
2 00	1·86	·030

* In the first of these experiments the deflections were measured by a scale in front of the bar, the micrometer-screw not being ready.

Weight in tons.	Readings by Scale.	Deflections for each half ton.
2·50	1·84	·020
Weight removed.	returned to 1·95	
3·00	1·67	Elasticity injured.
Weight removed.	1·81	

PART 1. BAR No. 6.

No Weight.		
·50	1·56?	
1·0	1·50	
1·5	1·48	·020
2·0	1·45	·030
2·5	1·24	·210 Elasty. inj'd.
3·0		

PART 2. BAR No. 6.

Weight by Tons.	Readings by Micro. Screw.	Deflections for each half ton.
No Weight.	·025	
·50	·043	·018
1·0	·068	·025
1.5	·091	·023
2·0	·128	·037 injd.
2·25	·178	·100
2·50	·313	·185

PART 1. BAR No. 7.

No Weight.	·031	
·50	·053	·022
1·0	·077	·024
1·5	·096	·019
2·0	·126	·030
2·5	·147	·021
3·0	·211	·064 injd.

PART 2. BAR No. 7.

No Weight.	·025	
·50	·056	·031
1·0	·077	·021
1·5	·098	·021
2·0	·109	·011
2·5	·137	·028 injd.
3·0	·180	

PART 3. BAR No. 7.

No Weight.	·075?	
·50	·130	
1·0	·153	·023
1·5		·023
2·0	·199	·023
2·5	·220	·021
3·0	2·90	·070 injd.

PART 2. BAR No. 7—reversed.

No Weight.	·025	
·10	·054	·029
1·0	·092	·038
1·5	·153	·061
2·0	·235	·082

Elasticity clearly injured by the former experiment.

It appears from these experiments, that both parts of the Bar No. 5, (whose direct elasticity was 9·5 tons,) had their restoring power just preserved with a transverse strain of $2\frac{1}{2}$ tons on a bearing length of 33 inches. Hence in the formula,

$$d' = \frac{3\,l\,w}{4\,d\,a\,t}$$

we have $l=33$, $w=2\frac{1}{2}$, $d=2$, $a=2$, $t=9{\cdot}5$, and $d'=1{\cdot}62$ inches, depth of tension.

Consequently $d''=\cdot38$ inches, depth of compression, and the ratio of the area of compression to tension 1 : 4·3

In the first part of Bar No. 6, w is not quite 2 tons, and $t=8{\cdot}5$ tons ; and hence the ratio - - - - - 1 : 2·7

In the second part of the same bar, ditto - - - - - - - 1 : 2·7

In the first, second, and third parts of Bar No. 7, $w=2\frac{1}{2}$ tons, and $t=10$ tons - - - - - - - 1 : 3·4

As far as these experiments are authority, therefore, the neutral axis divides the sectional area of a rectangular bar in about the ratio of one to three and a half.

TABLE IV.

BAR No. 8.

Distance of bearing.	Breadth.	Depth.	Weights.	Deflections.	Deflections each ½ Ton.	REMARKS.
in.	in.	in.	tons.			
33	1·9	2	·125	·034		
			·250	·046		
			·500	·060		
			1·00	missed.	·019	Mean ·024
			1·50	·098	·019	
			2·00	·120	·022	
			2·25	·134	·028	w=2·25. Neutral axis 1 : 3·4
			2·50	·151	·034	
			2·75	·176	·044	Elas. inj. with 2·50 T

BAR No. 9.

33	1·9	2	·250	·047		
			·500	·055	·016	
			1·00	·077	·022	
			1·50	·097	·020	Mean ·021
			2·00	·123	·026	
			2·25	·132	·018	w=2·25. Neutral axis 1 : 3·4
			2·50	·145	·026	
			2·75	·164	·038	Elas. injd. with 2 50
			3·00	·120	·092	Ditto dest. with 3 00

BAR No. 10.

33	1·9	2	·500	·056		
			1·00	·076	·020	
			1·50	·095	·019	Mean ·024
			2·00	·124	·029	
			2·50	·151	·027	w=2·5. Neutral axis 1 : 4·2
			3·00			

In the above experiments, the iron was

all supplied by Messrs. Gordon, and was of the same quality as the Bar No. 7,—its elasticity may therefore be taken as ten tons, but it was not determined by testing, as in the previous experiments.

Deductions from the three last Experiments, confirmed by direct Observation of the place of the Neutral Axis.

These experiments, like the former, imply, according to the formula, that the neutral axis lies at about one-fourth or one-fifth of the depth of the bar from its upper surface; but a method was adopted in these to discover, if possible, its position mechanically. With this view, a keyway, or groove, was cut in the side of the bar one inch broad, and one-tenth of an inch deep,—thus reducing the breadth to 1·9 inches. To this keyway, or groove, was fitted a steel key, which might be moved easily; and when the strain was on, the key was introduced, which it was expected would be stopped at the point where the compression commenced, and this was accordingly found to be the case in two out of the three bars, but not in the third, the fitting not being sufficiently accurate. The other two, however, showed obviously a contraction of the groove, at about half an inch from the top, agreeing with the preceding computations. To make the results more certain, three other bars, exactly like the former, had deeper grooves cut, and the key more exactly fitted, and with these the results were as definite as could be desired. The key, as above-stated, moved smoothly and easily before the experiment; but when two tons strain were on, and the key applied, it was stopped, and stuck at a definite point. The strain being then relieved, the key fell out by its own weight; the strain was again put on, the key sticking as before; the strain being relieved, the key again fell, and so on, as often as repeated. Precisely the same happened with all the three bars. One of them was then reversed, so that the part which had been compressed was now extended, and exactly the same result followed: showing, most satisfactorily, that our former computed situation of the neutral axis was very approximate. The measurements obtained in these experiments being tension 1·6, compression ·4 giving exactly the ratio of 1 to 4 in rectangular bars. These results seem the most positive of any hitherto obtained; still, there can be little doubt this ratio varies in iron of different qualities; but looking to the preceding experiments, it is probably always between 1 to 3, and 1 to 5.

On the Stiffness of Rectangular Iron Bars, and their Deflections under different Weights.

Although it is necessary to know the actual resisting power of bars in their ultimate state of strain, in order to determine the relative strengths of differently-shaped bars, yet the question of most practical importance is the stiffness they exhibit when loaded with smaller weights; for we ought never to strain a bar so nearly to its full power of bearing, as to make this the immediate subject of inquiry.

The experiments recorded in the last section are applicable to this purpose, but as these are all of the same depth, it was thought more satisfactory to make a few other experiments on bars of different breadths and depths. They were performed precisely like the last, and therefore require no particular description.

Experiments on the Deflection of Malleable Iron Bars, under different Strains.

TABLE V.

BAR No. 11.

Distance of bearing.	Breadth.	Depth.	Weights.	Deflections.	Deflections each ¼ Ton.	REMARKS.
in.	in.	in.	tons.			
33	1·5	3	·125	·043		
			·500	·059		
			1·00	·074	·015	Mean ·0103
			1·50	·083	·009	
			2·00	·095	·012	
			2·50	·101	·006	
			3·00	·109	·008	
			3·50	·120	·011	
			4·00	·131	·011	
			4·50	·148	·017	w=4¼. Neutral axis 1 : 4·9 Elas. pres. at 4¼ tons.

BAR No. 12.

33	1·5	3	0	0		
			·50	·017		
			1·00	·037?		
			1·50	·052	·015	Mean ·0108
			2·00	·061	·009	
			2·50	·064	·003	
			3·00	·078	·014	
			3·50	·089	·011	
			4·00	·102	·013	
			4·50	·124	·022	w=4¼. Neutral axis 1 : 4·9 Elasticity injured.

BAR No. 13.

33	1·5	2.5	0	·006		
			·50	·003	·024	Mean ·0173
			1·00	·050	·020	
			1·50	·060	·010	
			2·00	·074	·014	
			2·50	·093	·019	
			3·00	·110	·017	w=3. Neutral axis 1 : 4·9 Elasticity preserved, 3 tons.
			3·50	·149		
			7·5	Bent 8	inchs.	

To reduce the law of deflection from these results, we may have recourse to two well known and well established formulæ: viz.

$$\frac{l\,w}{4\,a\,d^2} = S \text{ and } \frac{l^3\,w}{a\,d^3\,\delta} = E,$$

which are both constant quantities for the same material, w being the greatest weight the bar will bear without injuring the elasticity; consequently, when l is also the same in both, $d\,\delta$ will be also constant, a being the breadth, d the depth, and δ the deflection. That is, all rectangular bars having the same bearing, length, and loaded in their centre to the full extent of their elastic power, will be so deflected, that their deflection (δ) being multiplied by their depth (d) the product will be a constant quantity, whatever may be their breadths or other dimensions, provided their lengths are the same.

Let us see how nearly our several results agree with this condition.

In the several bars, Nos. 8, 9, 10, 11, 12, 13, multiplying the mean deflection for each half ton, by the number of half tons which excited its whole elasticity, and this again by the depth of the bar, we find

		Depth.
No. 8, ultimate deflection		·108×2=·2160
No. 9	- - - -	·094×2=·1880
No. 10	- - - -	·120×2=·2400
No. 11	- - - -	·0876×3=·2628
No. 12	- - - -	·0918×3=·2754
No. 13	- - - -	.1038×2½=·2595
		6) 1·4417
Mean	- - - - -	·2403

There is rather a large discrepance in bar No. 9; the others are as approximative to the mean as can be expected in such cases.

If we make the same trial on the three parts of bar No. 7, we have,

1st part	·116	× 2	=	·2320
2d part	·105	× 2	=	·2100
3d part	·115	× 2	=	·2300
			3)	6720
Mean	- - -		-	·2240
Former Mean	- -		-	·2403
			2)	·4647
General Mean	- -		-	·2323

We may therefore say, that any malleable iron bar, of 33 inches bearing, being strained to its full elasticity, will be so deflected, that its depth, multiplied by the deflection, due to 30 inches, will produce the decimal ·23; consequently $\frac{\cdot 23}{d}$ = the deflection, d being the whole depth in inches.

In this form, however, it applies only to rectangular bars. To make it general, we must estimate it from the neutral axis, which in rectangular bars, being $\frac{4}{5}$th of the depth below the upper surface, the above constant, when thus referred, becomes $\cdot 2323 \times \frac{4}{5} = .1858$. But, on the other hand, our instrument for measuring the deflection was but 30 inches long; it has therefore to be increased again in the ratio $30^2 : 33^2$, or as $10^2 : 11^2$ on this account; so that, ultimately, the formula is $d'\,\delta = \cdot 22$ d' denoting now the depth of the bar below the neutral axis, and in this form it is general for parallel rails of any section whatever.

A curious circumstance was observed in these experiments, which, although it has no immediate bearing on the subject in question, it may be well to notice, and which is, I apprehend, characteristic of good malleable iron, viz. that the resistance to compression, although so much greater than the resistance to extension, is the first of the two which loses its restoring power; for if we so far increased the strain as to overcome the elastic power, the point of compression descended to nearly the middle of the depth, proving that the tensile force, although so much less, is the most tenacious; whereas I suspect, that in cast iron it is the reverse, that is, it is here the tensile power which first yields, and the consequence is a sudden fracture, and momentary destruction of the bar.

On the Sectional Figure of greatest Resistance, the Area being given.

Having established the preceding data, I might now proceed directly to find, with a given sectional area, the figure of greatest resistance; but this would be of little advantage, for the form we should arrive at would be quite inapplicable to a railway, as it would require the metal to be principally collected in the lower table; whereas, in the railway bar, we must of necessity bestow a certain quantity, perhaps two-fifths of the whole, in forming the upper table on which the carriage runs; it is, therefore, only after this is provided for, that we are at liberty to dispose of the remaining part of the metal, and even in this distribution regard must still be had to practical convenience. Instead, therefore, of determining mathematically, the area of maximum resistance, the most useful plan will be to compute, directly, the resistance of such sectional figures as fall within the limits of practical application, and to select from them that which, under all considerations, is the best.

The three forms of rails which, under this restriction, will have to be considered, are the following:

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

1. The plain T shaped rail, fig. 1.

2. The H, or double T, formed rail, with a lower table, as fig. 2.

3. The Trapezoidal rail, as fig. 3. Each of which will admit of various changes of proportions, without altering the general character of the section.

The upper and the lower tables are here represented as rectangular, with sharp edges. In practice these are rounded off, the metal thus displaced furnishing a sort of bracket between the table and stem, or rib, as shown in fig. 4; but to treat of them in this form would introduce great intricacy into the calculation, without much affecting the results. It will therefore be sufficient to consider them as rectilinear.

I would here observe, also, that some projectors have made the upper and lower tables of equal figure, upon the distant contingency, that when the upper table has been worn down, the rail may be turned, and the lower table made the upper. But this is certainly providing without foresight; for the bottom table is the most efficient for strength, and it would be a very dangerous experiment, after one side of a bar has been submitted for many years to a high compressing force, and its substance (by the hypothesis) greatly worn, to turn the rail, and expose this worn part to a still greater strain, but tensile instead of compressive, which could not fail instantly to destroy it. Instead of this, therefore, I should certainly recommend to work whatever metal is introduced into the lower table or web, into that form which is most efficient for present purposes, without regard to the contingency alluded to above.

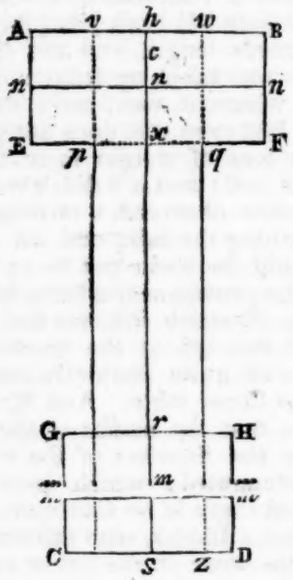
That the rail is deteriorated by exposure and wear, is undoubtedly true; although, perhaps, the amount is not yet well ascertained. Amongst the papers submitted to Messrs. Rastrick and Wood, with whom I was associated, we found it estimated at the rate of $\frac{1}{6}$th of a pound per yard per annum; but I have since seen it stated, in a letter from Mr. Dixon to Mr. Bidder, at $\frac{1}{10}$th of a pound per yard per annum. This was determined by taking up three rails, having them well cleaned and weighed, and then putting them in their places, and afterwards washing and reweighing them at the end of a twelvemonth, when two of them were found to have lost $\frac{1}{2}$ lb. in weight for the 5 yards length, and the third $\frac{3}{4}$ lb., which last was taken up from a particular situation, where it was more exposed to friction. But even this does not prove that the whole loss of weight is in the upper face of the rail; and if it did, it would be, as I have before observed, a stronger reason for not turning the rail: and, on the other hand, should the waste not be on the upper surface, the provision alluded to is unnecessary. Mr. Rastrick informs me, that even the small fins left at the meeting of the rolls are still quite distinctly seen on the face of the upper table. And Mr. Stephenson states, that the marks of the tools left in turning the flanches of the wheels are seldom obliterated; which proves, at all events, that there is no side wear.

Mr. George Bidder, who attributes all the waste to the wear on the upper surface, estimates the annual reduction at $\frac{1}{90}$th part of an inch; in which case the rails would not last more than thirty years before they would require to be replaced. And it then becomes a question, whether, in point of economy, it would not be better to lay an additional third of an inch upon the upper table, which would, by this reckoning, make the rail last sixty years. This increase of $\frac{1}{3}$d of an inch would call for an additional expense, to the amount of about $7\frac{1}{2}$ per cent. on the present cost; and this $7\frac{1}{2}$ per cent., at compound interest, would amount to about 30 per cent. in thirty years. If, therefore, a charge of 30 per cent. at the end of thirty years, would meet the amount of re-manufacture, and supply the waste, the two accounts would be about balanced. In this case, I must consider the latter as preferable. 1st. Because the other plan would increase the weight of the bar, and the difficulty of the manufacture, and probably diminish its soundness. 2d. Because thirty years' experience may introduce improvements, of which, at the end of that period, it would be desirable to take advantage. And, lastly, because I do not (judging from the opinion of different practical men) think that it has yet been

clearly determined what part of the waste is due to wear on the upper face.

To return again to the subject of the best formed section, I beg to repeat, that whatever figure the above, or other considerations, may lead practical men to adopt in the upper or lower table and rib, it will be fully sufficient for the purposes of calculation, to consider them as rectilinear, which will greatly facilitate the investigation, without sensibly affecting the results.

Comparative Strength of differently-formed Parallel Rails.



Let A B C D (above figure) represent any rectangular rail with a bottom table; $n\ n$ its natural axis; c the centre of compression, $c\ n$ being $\frac{2}{3}$ of $h\ n$. Now, the tension of each fibre being as its distace from the neutral axis, and that of the lower fibre being given equal to t, the tension at any variable distance x will be $\frac{t\,x}{d}$ (d being taken to denote the whole depth $n\ s$,) and therefore the sum of all the tensions will be,

$$\frac{t}{d'}\int x.\ d\ x \qquad (1)$$

which, therefore, becomes known, x being taken within its proper limits, according to the figure of the section.

But as the effective resistance of each fibre is also as its depth below the line $n\ n$, the sum of all the resistances will be,

$$\frac{t}{d'}\int x^2.\ d\ x \qquad (2)$$

x being taken here also within its proper limits. And then to find the centre of tension, or that point into which, if all the tensions were collected, the whole resistance would be the same as in the actua case, this would be given by the formula:

$$\frac{f\,x^2.\ d\,x}{f\,x.\ d\,x} \qquad (3)$$

which is precisely the expression for the centre of oscillation of a disc of the same figure.

We have hence the following general rule for finding the resistance or the weight which any given bar or rail will support at its middle point, within the limits of its elastic power, that is,

Calling the integral of formula (1) = A
do. do. formula (2) = B
do. do. formula (3) = D
And the distance $c\ n$ = C

then, referring the sum of all the resistances B to the common centre of compression, we have,

$$\text{D} : : \text{D}+\text{C} : : \text{B} : \frac{\text{B (D}+\text{C)}}{\text{D}}$$

which is the whole effect.

For those who understand the integral calculus, this solution is sufficient; but as the article will probably be consulted principally by practical men, it will be more convenient to give a specific solution for a rail, embracing under one general figure all the usual forms, the only variations being in the depth, breadth, and thickness of the parts. (See preceding figure.)

Let A B C D represent such a section, of which all the dimensions are given, as also the position of $n\ n$ the neutral axis, the point c which is the centre of compression, $c\ n$ being $\frac{2}{3}$ds of $n\ h$, and the point m which is in the centre of $r\ s$. The breadths $n\ n$ and $m\ m$ are also known. Then the resistance of the whole section referred to the common centre of compression c, may be considered to be made up of the three resistances.

1st. Of the middle rib, continued through the head and foot tables, $v\ t\ z\ w$.

2d. Of the head A E F B, minus the breadth of the centre rib.

3d. Of the lower web, G C D H, also minus the continuation of the centre rib.

Now, t being taken to represent the tension of iron per square inch, just within its limits of elasticity, we shall have,

1. Resistance of . . . $vtzw = \frac{1}{3}\ hs.\ ns.\ pq.\ t$
2. Resistance of A E F B = $\frac{1}{3}\ hx.nx.(nn-pq)\ \frac{nx}{ns}t$

Now, let $nm+\frac{rs^2}{12\ nm}=\delta'$, and $\delta'+cn=\delta''$, then

3. Resistance of G C D H = $nm.\ rs.(mm-pq)\ \frac{\delta''}{d'}t$

These three resistances being computed, let their sum be called s, and the clear bearing l; then $\frac{4s}{l}=w$, the load the bar ought to sustain at its middle point, for an indefinite time, without injury to its elasticity.

[*To be continued.*]

We find in the Newark Daily Advertiser, the following account of something new in the way of propelling boats.

"Dr. PLANTOU, of Philadelphia, is now exhibiting at No. 92 Broadway, New-York, a model of his method of constructing and propelling steamboats, and will be happy to show and explain its principles to all who will do him the favor of a call. The principle is the propulsion of boats by means of water-tight revolving cylinders, furnished with paddles. One of these cylinders is placed at each end of the boat—and acting both as buoyancers and propellers, they effect, as the inventor very satisfactorily demonstrates, the important object of impelling the boat over the surface of the water without having to overcome the great resistance encountered by the usual method of forcing it through the water. The current created by the action of the forward cylinder passes entirely under the boat, and by lifting it up, aids in impelling it forward.

"Dr. Plantou's models, &c. were submitted to a select committee appointed by the last Legislature of New-York, who recommended them to the favorable consideration of the canal board. The Board have since expressed their approbation of the project."

[From the Boston Courier.]

PERNICIOUS INFLUENCES.—If there is any curse hanging like an incubus over the youth of our country, it is the spirit of *imitating* the fashionable follies of the day. Multitudes on multitudes—promising, intellectual, moral—the pride of their associates and the hope of their parents—are ruined, utterly and irretrievably, as they sink, step by step, beneath the pernicious habits and blighting examples of the thoughtless, gay, flippant, and wicked devotees of fashion and the votaries of folly—

To whose means
There's more of depth than to their brain.

From the foolish belief that they are rendering themselves objects of fashionable attraction, and winning the smiles of the patrons of the *ton*—they follow an *ignis fatuus* that inevitably bewilders them into the morasses of vice and the quagmires of debauchery. See the youth—fresh from his native bowers and verdant fields—with his rosy cheeks and athletic frame: his manners, simple, unostentatious, polite, and his habits pure as the genial air, from the blooming borders wherein he gambolled from earliest boyhood. See him—an example of health, happiness and purity. He enters the pent-up city—peeps in upon the fashionable rounds—gazes upon the numerous and bewitching amusements: and anon partakes of its indulgences and drinks of its follies. It's a new scene, and he breathes a new atmosphere. His brain is oppressed, dizzied, bewildered:

He sees—he wonders—and adores.

I had a friend—a free-hearted, chivalrous youth. He left the thatched cottage and green fields for the smoky atmosphere and clustered streets of the city. He was a youth of no common mind—kind, benevolent, upright—and would naturally draw around him those who might love him for his virtues. He was the pride of an indulgent and generous father, who soon after went down to his final rest. He left a large property for three children. Edward was soon of age and came into possession of his share. It was large and generous, and made him wealthy. With it he went in to trade, and for a little while was prosperous—wonderfully prosperous. But the demon was upon him: he neglected his business—left it to others—followed pleasure, and became a fashionable buck—behind none in the liberality of means or the prodigality of time. He went from home often—and finally closed his business and went for good. I met him in the great metropolis. But the impression made upon my mind I well remember—but cannot describe.

It was some years onward when I was again in the same metropolis. With a worthy friend I wandered abroad. We stretched down the great thoroughfare—where

All tongues and kindred meet,—

till the dusk of evening closed upon us, and we found we had dropped unwittingly into a narrow avenue, leading in an adverse direction. We wandered on—indistinctly guided by the faint glimmerings of the scattered lights; and as we turned almost an acute angle, into an intersecting lane, we stumbled over the body of a human being, stretched upon the narrow side-way on which we stood. Humanity prompted—and we took him to a neighboring dwelling. It was the bloated and unsightly figure of poor Edward, in the last agonies of death. *He had been a drunkard and a gambler.*

T. K.

ADVICE TO APPRENTICES. — 1. Having selected your profession, resolve not to abandon it; but by a life of *industry* and

enterprize, to *adorn* it. You will be much more likely to succeed in business you have long studied, than in that of which you know but little.

2. Select the *best* company in your power to obtain; and let your conversation be on those things you wish to learn. Frequent conversation will elicit much instruction.

3. Obtain a friend to select for you the *best* books on morality, religion, and the liberal arts, and particularly those which treat on your own profession. It is not the reading of *many* books that makes a man wise, but the reading of only those which can impart wisdom. Thoroughly understand what you read; take notes of all that is worth remembering, and frequently review what you have written.

4. Select for your model the *purest* and *greatest* characters; and always endeavor to imitate their virtues, and to *emulate* their greatness.

5. Serve God; attend his worship; and endeavor to set an example of piety, charity and sobriety, to all around you.

6. Love your country; respect your rulers; treat with kindness your fellow apprentices; let your great aim be usefulness to mankind.

7. Get all you can by honest industry; spend none extravagantly; and provide largely for old age.

8. In a word, think much, act circumspectly, and live usefully.

[From the American Journal of Science and Arts.]

On Turnouts in Railroads, with Flexible Moveable Rails. By Thos. Gorton, Civil Engineer.

At a time like this, when railroads are being rapidly introduced in various parts of the United States, it is believed that any improvement relating to the various parts of their construction will be acceptable to the public.

Up to the present time all turnouts upon railroads, (so far as the writer's knowledge extends,) have been constructed with stiff moveable rails. When these stiff rails are moved round so as to make a communication with the turnout and main line, a rectilinear angle of several degrees is formed by the stiff rail and main line, which subjects cars passing through the turnout to much jar and lateral friction. This friction is so great as to injure both cars and railroad. In a late conversation with Mr. E. Miller, superintendant of machinery on the Portage railroad, he informed me that they proposed using *flexible* moveable rails for their turnouts. The rail adopted on that road is the parallel edge rail, eighteen feet long, and weighing forty pounds per yard. I understood that the plan of their turnouts was not fully matured, but that it was contemplated to have about three feet of the rail made fast in two heavy chairs, and the other fifteen feet to be sprung into a curved form, when it was desired to pass into the crossing or turnout.

This at once appeared to me to be a decided improvement, in as much as turnouts might be made on this principle, so that cars might pass through them with the same facility as in the curved parts of the main line. In examining the subject, the first requisite is, that the rail at the moveable end should be deflected so as to leave a sufficient distance between the rail of the main line and the fixed part of the turnout. Then, secondly, let the radius of curvature for the turnout be determined; it will be seen that these two requisites determine the length of the moveable rails. These rails may then be laid down in the following manner.

Let about one foot of that part connected with the main line be made fast in a heavy cast iron chair, by a wedge, and by a bolt passing through the chair and rail. The moveable part of the rail may be supported on chairs; these chairs to rest on cast iron seats, having a ledge on one side for the chairs to slide against when the rail is sprung round into the turnout. The seats consequently must be laid down in the curve form which the rail is to assume in the turnout. If it is thought that the chairs on this part of the rail will work out of place, they may be bolted to it, or secured in some other manner by guides on the seats. The two moveable rails of a turnout should then be connected by two or three stiff coupling bars, to give them permanence, and preserve the proper distance between them. The rails may then be worked by a vertical lever of a suitable length. This lever, with a ball placed upon its top, will serve as an index to persons travelling the road, by pointing out the position of the moveable rails, that the cars may be stopped in time, if the rails are not right.

The result of some calculations for rails of different lengths will now be

given, together with the length of a turnout for each kind of rail. These calculations are made for a double track of railroad, the distance between the rails of each track being 4.75 feet, and the distance between the inner rails, including the width of each rail, five feet. But as railroads in general do not differ much from this in outline, the length of a turnout will not be affected much by such difference.

The following table will be understood from the explanation given therein.

Radius of curvature in feet.	Length of movable rail not including that part in the heavy chair.	Deflection at end of rail in decimals of a foot.	Angle of crossing plates and sine of arc at each end of turnout, in feet.		Feet of straight line in the centre of turnout.	Length of turnout in feet.
310.	15 ft.	0.36	7°	37.78	40	115
350.	16	0.36	7°	42.65	35	120
400.	17	0.36	7°	48.75	30	128
410.28	17	0.35	7°	50.00	29.6	129.6
450.	18	0.36	7°	54.84	23	133
500.	19	0.36	7°	60.93	17	139
550.	20	0.36	7°	67.03	11	145

In the above table, fractions of a foot have been omitted in the last two columns, the object being to give sufficient information in a tabular form, from which a comparison of the advantages and disadvantages may be made for turnouts with moveable rails of different lengths, and arcs of different radii. An angle of 7° has been adopted in this table for the crossing plate. Increasing this angle would shorten the turnout but little. It is hardly necessary to mention, that the plan of the turnout proposed here is that of an inverted curve, with a piece of straight line in the centre.

It is believed that a turnout of from 400 to 500 feet radius, with flexible moveable rails, will be found to answer a much better purpose than those in use at the present time. Several important railroads have curves as abrupt as this. On the Baltimore and Ohio railroad there are two sharp curves, one of 337, and the other of only 318 feet radius.

[From the American Journal of Science and Arts.]

On the Resistance of Liquids to Solid Bodies moving in them.

This is an interesting subject of inquiry, and that branch of it which relates to the greatest practical velocity of boats and vessels appears to be of great importance. Circumstances have occurred within a few years, which have invested this subject with novelty and interest sufficient to engage the attention of scientific men, and roused them from the apathy which generally attends the investigations of physical facts and relations, which were supposed to have been well ascertained. It has been observed when a boat moved in a canal at the common velocities of three, four, or five miles an hour, that a wave preceded her, and greatly retarded her motion; and that if the boat was urged to a velocity of ten or twelve miles an hour, the wave entirely subsided, the bow of the boat being gradually raised out of the water as the velocity increased, and that a less proportional force was required to move her at the greater than at the lesser velocities.

These were all received as startling facts, and caused much theoretical speculation; but they are only such effects as should naturally result from the laws of resistance, which have been determined with considerable accuracy, and some of the effects intimated long ago by the French philosophers, to wit: by D'Alembert, in 1743; by La Place, in 1776; by Bossut, in 1778; by La Grange, in 1786; by Coulomb, in 1800; and by many others at different times in other countries.

La Grange ascertained that a wave of water, where it was one foot deep, moved 5.495 feet per second, and that the velocity of waves of water of different depths are as the square roots of the depths; consequently, the wave in a canal which is four feet deep will move 10.99 feet per second, or about seven and a half miles an hour. As the time in which a pendulum performs its oscillations is in a certain proportion to its length, and not in proportion to the magnitude or intensity of the force which first caused its motion, so the velocity of waves, being a similar motion, is in a certain proportion to the depths of the water, and not to the impulse of the boat which produces them. We ought therefore to expect, as the legitimate consequence of the long established premises, that as the velocity of the wave in a canal depends only on the depth of the

water, the boat, when urged with a greater velocity, must pass ahead of the wave, which will then subside, the cause of its rise and continuance having ceased to act.

We here refer to ordinary circumstances, where the breadth of the canal is three or four times the breadth of the boat, so that the wave has its natural action, and not to a canal so narrow that the boat necessarily pushes the water before her like a piston.

The partial rising of the boat out of the water at great velocities, is caused by the inertia and the mutual attraction of the particles of the liquid, and because the air opposes comparatively very little resistance, or about seven hundred times less than water.

If we take a solid body, whose specific gravity is equal to or greater than that of water, and put it into the water very slowly, we perceive but very little resistance; but strike the water with great velocity, and we find the resistance to be nearly as great as when we strike a solid rock, because it requires a certain time for the particles of any liquid to move among themselves; and if the boat moved with a *very* great velocity, she would of course rise entirely out of the water, and slide on it as though it were ice.

If the boat and water were covered with clarified oil, she would, from the same cause, descend under the water; because the oil would cause a resistance about seventeen times greater than the water; and if the water and boat could be practically covered with alcohol without mixture, the boat would have a small tendency to rise at great velocities, because the resistance of alcohol would be but one third of the resistance of water. The laws of the resistance of liquids in all the various circumstances in relation to it, have not been ascertained with the accuracy and precision which the present state of knowledge of other subjects seems to require; this may be owing in part to some hasty generalizations of the early philosophers, and also to the abstruse nature of the subject. It is now generally admitted that the direct perpendicular resistance of a plane surface, moving in a liquid of indefinite extent, and in a direction at right angles to the plane, is nearly equal to the product of the square of the velocity, the density of the liquid, and the area of the plane. This may be rigorously exact within certain limits, but may not be true when the velocities are very small or very great. It has also been admitted, that when the plane is inclined to the direction of its motion, the resistance is proportional to the *square of the sine* of the angle of inclination. This has been denied, and the resistance stated to be proportional to the *sine* of the angle of inclination. Is it *necessarily* true, that this oblique resistance is proportional to the sines, or some other lines relating to circles, or to some power of them? And is it not possible that the proportion may have a nearer relation to some of the properties of a parabola or an ellipse, than to those of a circle?

In 1778, Bossut and Condorcet made many experiments to ascertain the resistance of liquids. The reservoir of water was two hundred feet long, one hundred feet wide, and eight and a half feet deep. They used a solid in the form of a cube, whose side was five feet; it was sunk four feet in the water, and to one of the sides were attached, successively, triangular prows or bows of various angles, from twelve to one hundred and sixty-eight degrees, and it was moved with different velocities through a space of ninety-six feet.

The results of these experiments exhibit a resistance at all angles greater than the *squares* of the sines, and also greater than the *sines* for angles between 0 degrees and fifty degrees, but less than the sines between fifty and one hundred and eighty degrees. The brief account we have of these experiments appears to be defective, in not stating the absolute velocities of the solid; and the method is also objectionable, because with the lesser angles of the prow, a solid of much greater surface and volume was used than with the greater angles, without making any allowance for these items; so that between the angles of 180° and 12°, the surface in contact with the water, (exclusive of the stern,) was increased from 85 to 335.73 square feet, and the volume of the water displaced was increased from 100 to 337.8 cubic feet. If these circumstances are of no consequence, then a very large vessel

ought to be as easily moved as a very small one.

We want a set of experiments made with solids, all having the same volume or displacement, but having bows and sterns of various forms, to ascertain what form of bow will displace, and also what form of stern will replace, the given volume of water with the least motive force.

To displace the water, and also to replace it, with the least disturbance, is the desideratum. Some attention has been given to the displacement, but very little to the replacement; hence the water lines of boats and vessels, contiguous to the stern and stern-post, are generally concave, which is highly detrimental to fast sailing; because the concavity next to the stern requires a convexity, (before we arrive at the section of greatest breadth,) of much shorter radius than would be required if the water line presented a concavity from the stern to the midship section; and these two curves in contrary directions virtually double the inertia of the water—the concavity throws it off at right angles to the vessel, and it then has to assume a new direction, and pass round a curve of shorter radius to approach the stern. The concavity of the stern retards the replacement, by causing the water to pass along a curve instead of a straight line, which is evidently the shortest; and because the water will not even pass along a straight line, in a direction from the broad part of the vessel to the stern post, when the velocity is considerable, but leaves a hiatus or cavity near the stern post, and deprives the vessel of the benefit of the re-action of the water there—a certain convexity in all the water lines near the stern would therefore improve the sailing.

It may be said that such a vessel would steer badly; but we hear no complaint of the difficulty of steering vessels or boats with pink or sharp sterns. All the water lines should be convex in every part of them. As it is generally admitted that the resistance is in some proportion to the magnitude of the angle of inclination, it is evident that a vessel having a sharp bow will sail faster, with a given motive force, than another vessel of the same displacement, with a blunt or obtuse bow. We may obtain a very sharp bow without sacrificing any other good property, by projecting the lower part of the stern and bow, in the form of a semicircle, beyond a perpendicular let fall from the fore part of the deck.

About ten years ago the writer made a model of a pleasure boat upon these principles, but not then residing near any navigable water, the boat was not built.

The breadth was about two-sevenths of the length, with a very full midship section, and floor of the usual length, and the depth from a deep load water line to the upper side of the keel was about half the breadth. This depth was divided into four equal parts by horizontal planes, as usual, the edges of which are called water lines, and were all convex in relation to the axis in every part. The angle of the bow at the first water line was 28°; at the 2d, 38°; at the 3d, 40°; and at the 4th, or deep load water line, 100°. But by the common method of construction, with the same length and breadth of deck, and a less displacement, the angles would not have been less than 74°, 100°, 140°, and 156°, respectively. According to the results of experiments on the resistance of liquids, a boat or vessel built after this model would not have more than two thirds of the resistance of one built after the models in common use. The bow of this model was formed by extending the keel to a perpendicular line from the fore part of the deck; and from a centre in this line, a little above the second water line, and with a radius equal to the distance from the centre to the keel, a semicircle was described, but not quite completed, being met by another curve from the top of the stern of much shorter radius, and in a contrary direction. The profile will be singular, but not disagreeable when we are accustomed to it.

The water lines consist of different portions of parabolic curves. The curves of the water lines, in the direction from the stem to the stern, were taken from the parabola in a direction from the greatest ordinate towards the vertex. If we draw a rectangle, whose length is equal to the length of the vessel, and whose breadth is equal to half that length, and on this rectangle construct the common parabola, so that the axis shall be coincident with one of the longest sides of

the rectangle, the vertex in one of the angles of the rectangle, and the opposite short side of the rectangle coincident with and equal to a semi-ordinate to the axis of the parabola; then the proper curvatures for certain portions of the several water lines may be found in this parabolic curve, and it is highly probable that all of them may be designated as being between certain ordinates. Perhaps a parabola of greater dimensions may furnish more convenient curves.

The writer has had some experience in the sailing of boats and vessels—is confident that his expectations might be realized, and earnestly hopes that a vessel may be constructed on the principles assumed.

[From the Railroad Journal.]

PROBLEM.

To determine a grade, which will produce the same consumption of power, in a rectilinear railway, as is produced by a level curvilinear track of 800 feet radius, with a given degree of motion.

Solution. Let V denote the velocity of the car in feet per second; R the radius of curvature in feet; W the weight of the car; m the distance in feet, through which a heavy body will fall in the first second of time near the earth's surface; G the required grade per mile in feet.

Agreeably to the laws of centripetal forces, $\frac{V^2}{2mR} \times W =$ the centrifugal force of the car; and which expression will consequently exhibit the lateral pressure on the side of the rail very nearly. Hence, agreeably to the laws of friction, $\frac{V^2}{8mR} \times W =$ that part of the moving power which is consumed in consequence of centrifugal force.

From the science of mechanics we therefore have, $5280 : G :: W : \frac{V^2}{8mR} \times W$, and consequently, $G = 660 \times \frac{V^2}{mR} = 41 \times V^2 R$ nearly.

From the above formula it is easy to compute the following table, exhibiting the grades which are equivalent to a curve of 800 feet radius, with different degrees of motion.

Radius of curvature in feet.	Velocity of the car in miles per hour.	Corresponding grade in feet.
800	2	0.440
800	4	1.760
800	8	7.040
800	12	15.840
800	20	44.000

METEOROLOGICAL TABLE,

For the month of May, 1835—kept at Avoylle Ferry, Red River, Lou. (Lat. 31° 10′ N., Long. 91° 59′ W. nearly,) by P. G. VOORHIES. [Communicated.]

Days.	Morn.	Noon.	Night.	Wind.	Weather.	Remarks.
1	68	64	63	NW	cloudy	heavy rains and thunder all day
2	58	78	76	calm	clear	
3	68	82	78	..	..	Red river falling
4	70	82	77	SW	..	
5	72	80	78	calm	..	
6	66	81	76	..	..	
7	71	80	77	SW	..	
8	72	84	79	SE	..	high wind
9	64	70	68	NW	..	.. .. —all day
10	60	69	64	calm	clear	Red river on a stand
11	66	82	78	..	..	
12	72	81	76	S	..	
13	74	83	80	..	..	
14	72	86	80	SW	..	
15	64	78	74	N	..	
16	60	77	70	calm	..	
17	58	80	73	..	..	
18	60	78	72	SE	..	light wind
19	71	78	76	..	cloudy	thunder storm at noon
20	71	83	80	calm	clear	cloudy evening — Red river rising
21	70	85	78	..	..	
22	70	83	80	SE	..	
23	70	84	80	calm	..	
24	70	84	75	S	cloudy	little rain and thunder in the evening
25	71	81	78	calm	clear	
26	69	83	78	..	..	
27	68	84	80	..	..	
28	70	84	79	..	..	
29	69	85	81	..	..	U. S. snag steamboats, Capt. Shrives, passed down from the rafts on Red river — left unfinished, 23 to 25 miles: 3 steamboats, 1 keel
30	68	86	83	S	..	
31	72	86	84	..	..	

Red river rose this month, 1 foot 0 inches—and is below high water mark, 5 feet 2 inches.